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A NEW HOSPITAL ADMINISTRATION AND FINANCING**





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Side image is the models of Corona COVID19 virus.





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MEDIA REPRESENTATION OF CHINA: FRAMING ANALYSIS OF HONG KONG DISPUTES IN PAKISTANI MEDIA

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ABSTRACT

This study examines the inclination of two mainstream English daily newspapers of Pakistan in the context of war/peace Journalism by framing analysis of overall coverage regarding ongoing protests and disputes caused over introducing an extradition bill in Hong Kong, China. Secondly, this research evaluates the media representation of China in Pakistan based on news coverage of Hong Kong. The content analysis methodology and theoretical approaches based on peace journalism supported by framing were applied. The findings reveal that newspapers, i.e. *Dawn* and *The News* depict a higher degree of peace journalism frame in a total of 179 news stories. However, newspapers show favorable slants to protestors versus the Hong Kong government. Furthermore, Pakistan's newspapers highlight more neutral image of China. The salient and prominent indicators of Peace, like causes and consequences with people-oriented, are justifying the peace journalism practices in Pakistan's media.

Disciplinary: Multidisciplinary (Journalism and Mass Communication Sciences (Information and Media Sciences), Political Sciences (International Affairs/International Relations), Global Studies).

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1. INTRODUCTION

The historical backdrop of the world comprises a torrent of wars, disputes, and conflict spread over the globe and the role of media always ascertains its significance while covering these critical situations. Media messages assume a considerable job in molding geopolitical conditions (Ramasubramanian & Miles, 2018). Entman (1993) and Lasorsa (1997) observed, through framing, although media can vary when displaying a similar story or issue. News coverage is an essential feature of media to forming the course of occasions in war and peace. Each individual needs to depend on the media's information, and they visualize the picture of disputes and conflicts through the lens of media framing (Lee, 2010). Subsequently, media become an influential component in

constructing public perception regarding disputes and conflicts and that portray the image of linked authority or country (Zaheer, 2017).

By the time due to different kinds of interests, disputes and conflicts have become a critical phenomenon of each social nation. In 2019, along with ongoing war and disputes events in Palestine, Syria, and Afghanistan, the global media is more conscious and attentive about recent conflict in Hong Kong over the 2019 extradition bill proposed by the Hong Kong Government.

Hong Kong situated in the Southern part of China and was controlled by the British for 156 years either by ceded or on the lease after two Opium Wars. On July 1, 1997, Hong Kong reunified with mainland China as one Country, and the city maintained a phenomenal status of autonomy with an independent set of governing institutions. However, China has pledged to maintain the capitalist system in Hong Kong running for at least 50 years until 2047 under the notion of 'one nation, two systems.' As Special Administrative Region (SAR) of China, Hong Kong has experienced various political and social difficulties since the return to China's sovereignty in 1997, Such as the weak power of the Legislative Council as a split from 'pro-Beijing vs pro-democracy' to 'pro-government vs anti-government' and also heighten the pressure on and denunciation of the government (Ma, 2007).

However, disputes between Hong Kong and China have become gradually intensive in recent years, as can be seen in current widespread protests opposing the suggested extradition bill in Hong Kong, a bill that enables the extradition of criminal suspects for trial in mainland China. Protesters asserted that the suggested bill sabotage Hong Kong's judicial autonomy and consider the bill as a conspiracy to pursue political prosecution (Wang, 2019).

The recent crisis in Hong Kong is getting significant space in news media globally. Considering a neighboring companion and strategic partner, the current situation of Hong Kong and China has continuously received noteworthy news coverage in Pakistan's media. Simultaneously Pakistan and its media are also engaged in raising the voice against India over Kashmir due to prolonged lockdown and cancellation of Kashmir's special status. The growing power of China and its status as a permanent member of the United Nations Security Council has increased the need for China's support to Pakistan at a global platform over the Kashmir issue. China is facing massive criticism over Hong Kong disputes and possible interferences by western countries. Therefore, China also needs the endorsement of many countries to recognize the Hong Kong dispute as China's internal problem. Hence, Pakistan and China, two eternal companions, are expecting each other's support over Hong Kong and Kashmir respectively.

However, a gap is observed in the existing literature of war/peace journalism frame regarding any dispute situation in China like Hong Kong investigated in Pakistan or any other counties' news media. Therefore, it seems significant to conduct first of its kind of a framing research study on the representation of China regarding coverage of Hong Kong dispute in print media of an eternal companion country like Pakistan. The theoretical contribution has an immense scope in each research. Hence, the contribution of the current study is to extending the theories of framing and Peace Journalism to investigate the news coverage of dispute situations in Hong Kong, which is not previously been applied.

This study, research questions are:

Q1: To what extent the Pakistani press gives coverage to Hong Kong?

Q2: Based on what indicators in Pakistan's newspapers, which frame was dominated between peace or war journalism?

Q3: What kinds of slants are used by Pakistani newspapers?

Q4: What are frames dominant in Pakistan's newspaper representing China?

Q5: Discuss the Pak-China relationship based on framing analysis of China in Pakistani newspaper over Hong Kong? An Interpretive analysis.

2. LITERATURE REVIEW

This study attempts to provide a theoretical framework, a review of framing theory, mainly, peace and war journalism frames and their applications in media research.

2.1 MEDIA FRAMING

A vast number of people go to the news media every day, and "media" achieved a place as cornerstone organization in our democracies. Sociologist Erving Goffman in 1974 presented a framing theory as the organization, classification, and interpretation of everyday life experiences that empower the audiences to construct a sense of and present the meaning to the world around them (Goffman, 1974). Additionally, McCombs et al. (1997) concentrated that the framing is an expansion of agenda-setting concepts, and both represent a convergence. Framing includes a communication source showing and characterizing an issue and mainly applied to determine how media reshape the information and therefore transforms the responses of people to an overall scope of external stimulation (Vreese, 2005). Besides, Entman (2007) describes framing as "the way toward drawing up a couple of aspects of perceived reality and assembling a story that features the connections between them to stimulate a particular interpretation." Scheufele (1999) introduces two kinds of frames. First, media frames, which is an instrument utilized by media and legislators to produce salient points and second is audience frames, which are created by the individuals in their psyches. The frames in news media content also influence how the audience perceives the news. In a nutshell, the preeminent principle of framing theory is that a matter can be examined from a classification of points of view and be translated as having ramifications for multiple values or contemplations. Framing alludes to the procedure by which individuals develop a specific interpretation of an issue.

2.1.1 PAK-CHINA FRAMING IN MEDIA RESEARCH

The media establishes its significance not only by agenda-setting and inducing the debate on the positioning of a country's soft power but also in framing news stories to shape global inclinations (Nye, 2002). In this manner, framing is unavoidable over the path of news development. Globally scholars conducted framing analysis of China (Peng, 2004; Sparks, 2010) in worldwide media. In Pakistan's context, Munawar (2015) concluded a framing study in which Chinese news agency Xinhua portrayed a positive image of Pakistan. While considering the China-Pakistan relationship Yousaf (2014) and Rawan et al. (2018) conducted studies applying framing theory in the elite press of Pakistan, China, India, and US. These investigations revealed a positive portrayal of the relations by

Chinese and Pakistan newspapers however negative portrayal has been observed in the Indian and American the press. Considering the case of war against terrorism, Yousaf (2015) compares perceptions and the images of Pakistan in Associated Press of U.S. and Xinhua of China during the operation Zarb-e-Azb conducted by Pakistan's military against militants at border with Afghanistan.

It is observed that Pakistani media mostly covered constructive stories regarding China's economy, technology, social settings and firm relations with Pakistan to frame the positive image of China (Rawan et al., 2018; Z. Yousaf et al., 2014) and shape the public opinion according to their own aspiration and inclination. Because of the said argument, it seems lucrative to explore the frames regarding conflict reporting associated with ongoing protest and dispute situations in Hong Kong along with the representation of China in Pakistan's news media.

2.2 CONFLICTS AND MEDIA FRAMING

It is widely observed that audiences express more attention in arguments, disagreements, and rivalries like if an event attached to conflict, many people will be interested in that basis alone because it is human nature to choose sides and stand up for that choice (Forgette & Morris, 2006). Situations involved conflict about politics, religion, and wars generate the sensations in news stories and enhanced its newsworthiness (Bednarek & Caple, 2017). Media coverage frames and shapes the events happened during war and peace. Moreover, Jakobsen (2000) also notes that in order to create a sensation in the environment, the media focuses on conflicts only when incidents of violence are taking place.

2.2.1 WAR AND PEACE JOURNALISM

In the 19th century, to eliminate war reporting in support of peace journalism to encourage a culture of peace (Lee & Maslog, 2005), a sociologist from Norway Johan Galtung endorsed the methodology of peace journalism coverage, that is viewed as a therapeutic technique for dealing with regular coverage of conflict situations. Galtung (1986) discourses that deliberately or unintentionally, during conflict reporting, media contribute towards aggravating the situation. Focusing the fact that journalists have two ways to cover any conflict situation, either peace journalism or war journalism, but peace journalism approach is grander than war journalism as it stimulates a concentration on passionate coverage and pacifist or nonviolent proposition to report conflicts (Galtung, 1986). His categorization of peace journalism and war journalism depends on four extensive applications and lingual directions; first is harmony/disputes, second is reality/propaganda, third is public/elite and forth is resolution/disagreement. In comparison, war journalism is orientated in war/violence, propaganda, elite and victory (Lee & Maslog, 2005). McGoldrick and Lynch (2014) depicted peace journalism as a "more extensive, impartial, adequate, attractive and more authentic method for framing news stories, illustrating on the awareness of conflict analysis and metamorphosis." Moreover, the objective of peace journalism is to encourage the possibility of tranquility and to give a surplus equalized coverage regarding all affected and included conflict groups by keeping away from a contradictory style of news writing (Lynch & McGoldrick, 2014).

From a theoretical aspect, authors find framing theory is an appropriate and relevant for investigating peace and war journalism to analyze the inclination of Pakistani print media over constant alarming situation in Hong Kong because it describes how frames, and in this way, certain understandings, become entrenched inside media coverage (Fahmy & Eakin, 2014).

2.2.2 APPLICATION OF WAR/PEACE JOURNALISM FRAME IN MEDIA RESEARCH

History of news media coverage possessed many examples of war/peace journalism. The agenda of the media organization assumes a significant job in the coverage of such issues (Raza & Aziz, 2012). The result of most studies inclined toward war journalism frame, like a study compares two contesting frames of peace and war journalism in visual coverage of conflicts in Gaza (Fahmy & Neumann, 2012) and draw a conclusion that all three Western newswires, i.e., AP, Reuters, and AFP collectively present more war journalism frames focusing different aims and news markets while covering the Gaza War. Similarly, a study in the context of Talibanization and terrorism in Pakistan (Siraj, 2010) manifested that most of the news stories are framed in war journalism with the unfavorable slant of Taliban. The researcher argued that most of the dispute situations are reported as war journalism frames in lens of media. Shinar (2004) asserts that media vigorously adapt war journalism frames even if covering peace dialogs.

Supporting this argument and diverting towards the Asian perspective, Maslog et al. (2006) determine war/peace journalism in four regional conflicts in Pakistan, India, Sri Lanka, Philippines, and Indonesia with a conclusion that war journalism frame was dominant in overall news reporting of all regional conflicts.

While explaining the role of media in U.S foreign policy, Edward (1993) argued that mainstream media tend to follow and serve the government's agenda in reporting on foreign policy goals. Hence, media inclination toward peace or war journalism also represents a glimpse of a country's foreign policy. Likewise, in a study, Indian newspaper framed more war journalism on Indo-Pak conflicts over Kashmir issue which clearly indicates the endorsement of war culture between Pakistan and India while Pakistani newspaper framed more peace journalism and stressing that the conflict must be resolved peacefully by cooperation between both countries (Hussain, 2015).

Summarizing, theoretically, the concept of peace journalism (Galtung, 1986, 2003) has been allied to Goffman's framing theory in this study. Lee and Maslog (2005) noticed the supportive relationship between these two theoretical concepts. This study has two main objectives, first is linked with peace journalism theoretical framework in which authors explore the coverage of Hong Kong dispute in Pakistan's newspapers. The second objective directly linked with framing to determine the representation of China in Pakistan over Hong Kong dispute coverage.

3. METHOD

To examine the coverage of the Hong Kong issues in two English language newspapers of Pakistan including *The News and Dawn* were preferred and applied the content analysis of their overall coverage. An eight months tenure was selected, and news published from February 01, 2019 to September 30, 2019, were analyzed. In February, the Hong Kong Government proposed an extradition bill to establish a procedure for exchanges of fugitives not only for Taiwan but also for Macau and Mainland China. This proposal initiated a new spell of protests and disputes in Hong Kong. The marches and demonstration with eagerness are continued in the region and are also considered as a significant reason for period selection.

These two newspapers were preferred due to their circulation, distinction, and national and

worldwide reputations. Additionally, these papers are accessible in the English language, which is viewed as the most widely used language in the world, making it easy for global English readers, including policymakers and elites. Correspondingly, the two papers are considered to express many points of view that are consistently liberal and critical analytical of legitimate government strategies.

Data included overall coverage collected from websites of newspapers; 85 news items from *Dawn* (<https://www.dawn.com>) and 94 news stories from *The News* (<https://www.thenews.com.pk>).

3.1 CATEGORIES OF WAR/PEACE JOURNALISM

On the vindication of a pilot study, researchers selected the following categories as per the requirement of study from the Model of Galtung (2003).

Table 1: War/peace journalism categories

War-Journalism	Peace-Journalism
Visible effects: Including violent activities (casualties, destruction to property, shelling, arrests, etc.)	Invisible effects: Including emotional distress and disruption, damage to culture, society, environment
Difference-oriented: Reports on areas of dissimilarities that prompt exacerbate of conflict.	Solution-oriented: Coverage on areas that may proceed to a solution to the conflict.
Focuses on here and now: Neither reports on elements adding to conflicts nor ramification of it.	Causes and consequences: Specifically reports on components contributing to conflicts as well as repercussions of it.
Indicating and bifurcating good and bad sides: Point out the different quarters for liable of chaos in the conflict region.	Avoids Indicating and bifurcating good and bad sides: Reports avoiding to point out of good and bad sides or responsible for any issue.
Two-party orientation: Reports reveal the victory of a party and losses of another party.	Multi-party orientation: Give a platform and voice to various countries, not to be restricted to two countries.
Partisan: Reports representing partiality or expressing the one-side aspect and ignore the other side.	Non-partisan: Impartial or neutral reporting about all involved actors
Elite-oriented: Reports mainly focus on elites and leaders as actors and sources of facts and information	People-oriented: Reports mainly focus on the general public as actors and the origin of information
The utilization of victimizing language or emotive words: Reports utilize rigid words like crushed, pitiable, terrible, crippled, terrorist, cruel, assassination, genocide, etc.	Avoid victimizing language or emotive words: Reports avoid the use of rigid language and words, particularly in the titles.

3.2 CODING SCHEME

The researchers utilized qualitative and quantitative content analysis approach, that is a more appreciated and well-elucidated method of executing “the organized, neutral, qualitative and quantitative analysis of any communication physiognomies” (Neuendorf, 2017). The coding categories are constructed as per provided guidelines of the Galtung’s model, in which eight-eight indicators of peace and war journalism frame were employed. When the total number for peace journalism indicators exceeds the total number for war journalism, the news story is recognized as a peace journalism story. When war journalism indicators dominant peace journalism indicators, the story is categorized as war journalism. A score of one (1) is allotted each time when a story supports either war journalism or peace journalism frames. In case the equal number of presence of both war and peace journalism indicators coded as neutral. The entire news was the coding unit and a contextual unit also. Thus, the unit of analysis for the research was a complete news story.

The slant in news story is considered favorable for protestors or the Government if it portrays any of them positively and assigns a score of 1. Furthermore, considered unfavorable when news coverage reveals them as negative and assigns a score of 0. The rest is considered as neutral slants.

The researchers used 'pro-frame' and 'anti-frame' to examine the representation (Munawar, 2015) of China is covered in Pakistan's newspapers based on Hong Kong crisis. For these frames, the whole story would be contextually evaluated and any news story which favors China's position or any positive move by China would be professed as pro-frame and coded as 1. Every news story which does not support and having a negative stance towards China would be considered as anti-frames and coded as zero (0). Any news that does not have a positive or negative impression will be considered neutral.

Inter-coder reliability indicates the levels of agreement amongst independent coders who code similar content utilizing a similar coding instrument. Holsti's (1970) formula was used to examine the Inter-coder reliability of the content analyzed. A training on coding work was conducted for two independent coders. The inter-coder reliability calculated for randomly selected 19 stories (10.6% of total) covering Hong Kong. The data revealed an overall inter-coder reliability of 0.933. For slants, an additional random sample was selected, and data revealed 0.90 reliability. Similarly, for the representation of China, the result indicates 0.91 reliability. The result of all tests is higher than the standard ensure reliability value of 0.70 which satisfied the requirement of content analysis (Wimmer & Dominick, 2000).

4. RESULT AND DISCUSSION

This study split into two parts first is the framing of Hong Kong dispute regarding war/peace journalism frames, and the second part is framing the image and representation of China based on Hong Kong coverage in Pakistan's newspapers.

Q-1: To what extent the Pakistani press gives coverage to Hong Kong?

Pakistan's print media performs a significant role in not merely disseminating information about global disputes and conflicts to its readers but also in formulating their views on these issues. From February 2019 to September 2019, *Dawn* (674 news) and *The News* (789 news) have published 1463 news stories to disseminate the information about conflicts beyond Pakistan's boundary. Hence, disputes in Hong Kong received the third position in *Dawn* and fourth position in *The News*. The figure-1 is indicating that while covering global conflict, Hong Kong (12.23%) received the fourth position after Kashmir, Syria, and Palestine. The findings show that Pakistan's press is progressively engaged at war and conflict events arising in Muslim nations, but considering Hong Kong as a territory of China and occurring of regular dispute incidents has given Hong Kong a conspicuous position in the coverage.

This study consisted of 179 news stories regarding Hong Kong conflict, with 85 news (47.5%) from the *Dawn* and 94 news (52.2%) from *The News*. All selected news, utterly relevant to the incident and between 150-200 words-limit.

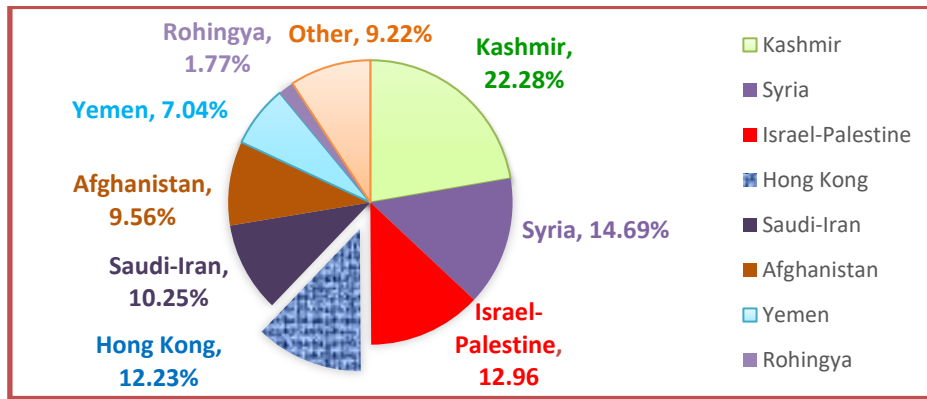


Figure 1: Coverage of global conflicts in the Pakistani Press

Q2: Based on what indicators in coverage of the Hong Kong conflict in Pakistan's print media, which frame was dominated between peace or war journalism?

Table 2 reveals that Pakistan's media is practicing peace journalism while covering the circumstances of Hong Kong and this approach is considered as a contribution to peacemaking. However, the existence and dominance of peace journalism frames over war journalism frames are established on Galtung's described indicators.

Table 2: War/peace Journalism Frame (N)

Newspaper	News Stories	PJF	WJF	Neutral
Dawn	85	47	34	4
The News	94	50	39	5
Total	179	97	73	9

PJF: Peace Journalism Frame; WJF: War Journalism Frame

A comprehensive analysis of the framing pattern was additionally done and finds 348 peace-oriented indicators as compared to 296 war-oriented indicators 179 stories in both newspapers, as shown in Table 5. Findings unveiled that peace journalism frames surpassed war journalism frames in coverage of the Hong Kong disputes, which provide a spacious space to the resolutions of the issues (Raza & Aziz, 2012). Amongst peace indicators, the highest number of indicators were in, "causes and consequences" and "people-oriented" because most of the news focuses on the general public and protestors with citing the causes of the conflict situation and all the possible complex consequences of the conflict. Contrarily in war journalism frames, most of the indicators were found in, "visible effects of war" with "utilization of victimizing language". Because newspapers have identified either protestors or police as liable for chaos during disputes and also observed the situations when protestors destroyed the property, disrupted the transportation system. While responding, police arrested the protestors, shelling the tear gas, fire the rubber bullet which injured the demonstrators.

Table 3: War/Peace Journalism Indicators.

War-Journalism	N	Peace-Journalism	N
Visible effects	60	Invisible effects	55
Difference-oriented	43	Solution-oriented	24
Focuses on present	20	Causes and consequences	80
Indicating good or bad sides	49	Avoids indicating good or bad	27
Two-side orientation	34	Multi-party orientation	25
Partisan	32	Non-partisan	34
Elite-oriented	6	People-oriented	63
Utilization of victimizing language	52	Avoid victimizing language	40
Total	296	Total	348

However, both newspapers have used more victimizing language and emotive words 52 (17.56%) than avoiding these terminologies in news stories 40 (11.49%). The words used in overall coverage communicate an alarming situation because if journalists consistently utilized war journalism words in news stories that will affect regional stability, peace, and development in the future.

Q-3: What kinds of slants are used by Pakistani newspapers in news coverage of Hong Kong disputes?

Table 4 indicates that both newspapers give favorable slants to protestors who are local public having right to protest and unfavorable slant to government authorities for imposing new policies against settled agreements as observed that media seeks to attract its readers by considering the nature of human interest in controversial sensational news (Bednarek & Caple, 2017).

Table 4: Slants for Protestors and Government (N).

Newspaper	Protestors				Government			
	Favorable	Unfavorable	Neutral	Total	Favorable	Unfavorable	Neutral	Total
Dawn	40	31	14	85	29	32	24	85
The News	44	22	28	94	30	45	19	94
Total	84	53	42	179	59	77	43	179

Moreover, Table 5 is representing that both newspapers reported the attacks and destruction activities among protestors and police in most of their news stories. However, results based on news coverage revealed that protestors focus more on peaceful demonstrations and only react violently when police on the orders of government used tear gas and rubber bullets to stop protests.

Table 5: Slants for protestors and Government with respect to frames

Frames	Protestors (N)				Government (N)			
	PJF(97)	WJF	Neutral	Total	PJF	WJF	Neutral	Total
Favorable	47	35	2	84	36	2	2	59
Unfavorable	22	31	0	53	34	42	1	77
Neutral	28	7	7	42	27	10	6	43
Total	97	73	9	179	97	73	9	179

Q-4: What are frames dominant in Pakistan's newspaper representing China in Hong Kong conflict?

Table 6, Pakistan's newspapers gave more balanced and slightly unfavorable coverage to China. Moreover, these newspapers are more focused on the neutral frame in 96 news stories (53.63%) about China. Authors have argued that both newspapers refrain from mentioning any indication of China's direct intervention in ongoing conflicts in Hong Kong which is considered to be the main reason for more balanced and neutral coverage. However, many news stories discussed the perception of Hong Kong people over a weak legislative system of China as well as expressed their anger over China for violating the autonomy of Hong Kong decided according to the Sino-British Joint Declaration. That becomes a cause of a higher degree of anti-frame news about China in newspapers. Conversely, newspapers also reported the role of China as a peace maintainer, situation controller as well as the right action towards Hong Kong people. These are considered as primary reasons for portraying China in positive frames in the newspaper's coverage regarding Hong Kong issues.

Table 6: Pro, Anti and Neutral frame regarding China.

Newspapers	No. of News	Pro-China	Anti-China	Neutral
Dawn	85	16	23	46
The News	94	20	24	50
Total	179	36	47	96

Q-5: Discuss the Pak-China relationship based on framing analysis of China in Pakistani newspaper over Hong Kong? An Interpretive analysis.

Hong Kong, as a business region of China and due to the ongoing conflict situation in the city as well as the marches against the government, gained prominence in the international media. Most of the western media wires are blaming China for supporting the Hong Kong Government and eroding the freedoms and autonomy of Hong Kong. However, China is represented a bit more unfavorable or negative versus positive because *Dawn* and *The News* are non-state media outlets, and both newspapers are using the more news source from western news agencies like AFP, AP, and Reuters rather than Pakistan's APP or China's Xinhua.

Besides the statements from western countries, based on Pak-China growing the friendly relationship and results drawn from present study, it is observed that Pakistani newspapers have portrayed China in a balanced or neutral manner on Hong Kong disputes and considered ongoing disputes in Hong Kong lighter than other existing conflicts around the world, especially in Muslim countries. This can be gauged from the Twitter message of the Prime Minister of Pakistan when he criticized the international media for given consistent headline coverage to ongoing protest in Hong Kong and ignoring the terrible human rights crisis in Indian held Jammu & Kashmir (Dawn, 2019b). Further, in a recent meeting of China's President Xi with Pakistan's Prime Minister Imran Khan, there was a clear indication that Pakistan had endorsed its commitment to the One-China Policy and repeatedly considered Hong Kong issues as an internal matter of China (Dawn, 2019a).

Additionally, it is regularly accepted that on certain matters, the media needs to pursue the government policy and cannot stay unbiased or nonpartisan in the conflicts particularly when its own country is involved or support any of the competitors (Bennett, 2003). Although witnessing the Pakistani media, it is seen that the government usually faced criticism by media, but the media shows elements such as nationalism and patriotism adheres to the government's policy, especially while dealing the national interest as well as international issues (Eijaz, 2012). Considering the case of the Taliban, Nadeem & Khan (2017) concluded in a study that newspapers in Pakistan pursue the foreign policy of the government. Summarizing, this study concludes that Pakistan's media adheres to the government's foreign policy, considering China and particularly Hong Kong's issue.

This study showed that the Government of Pakistan and media are perceiving the conflicts in Syria, Palestine, or Kashmir as an international disputed issue and recognizing Hong Kong as an internal issue of China. Similarly, China also supports Pakistan's stance on the Kashmir issue and refuses to call it India's internal problem. However, Pakistan's government wants to see a peaceful solution to Hong Kong's situation and keep up the interminable neighborly association with China. Moreover, Pakistani newspapers are endeavoring to portray a neutral representation of China by applying peace journalism practices to cover the situation in Hong Kong which a good gesture of Pakistan's media and foreign policy towards China.

5. CONCLUSION

The research aims to analyse the overall coverage of Pakistan's print media on the recent dispute situation in Hong Kong by employing the war/peace journalism and framing as theoretical approaches. The conclusion of this research revealed that the framing style of two Pakistani newspapers shows a similar tendency and consecutively leaning towards peace-oriented journalism. Perhaps, it justifies that China is not interfering in the ongoing dispute and trying to calm the situation.

The second part of this study relies on the representation of China based on the coverage of disputes in the Hong Kong region. The elevation of a positive image of a country is not something novel because the image of a country worldwide is quite important because by having a good image the country manages to achieve its foreign policies. However, this study expressed that Pakistan has represented China in a balanced manner, but used bit more anti-China frames while pro-China frames are less because the slant towards pro-democracy protestors is more favorable than Pro-Beijing Hong Kong Government.

Galtung (1986), the pioneer of the peace journalism approach argued that media reporters and editors have a chance to make choices during conflict reporting. While covering Hong Kong, Pakistani newspapers practiced peace journalism focusing on the basic and social reasons of violence, and does not focus on the simple discrepancy. Logically, Pakistan was the victim of the war on terror and faced internal and external conflicts for last 20 years, which make its media habitual to focus on visible war effects and use the diabolized language and emotive words while covering any dispute. However, the results of this study are justifying that transformation of tendency is observed in the Pakistani press from war journalism practices to peace journalism. Nevertheless, the results of this study are justifying that newspapers in Pakistan are now transforming their tendency to practice peace journalism from war journalism. However, for future aspects, this practice creates opportunities for media outlets in Pakistan and public on a large scale to consider the significance of non-violent retorts to conflict.

There are many limitations to this study. A broader study on the subject involving popular mediums such as digital media and television, which have a high impact on individuals. Further, media outlets from India or western countries could be included for comparative analysis. The future researcher could include an extensive period for this kind of study and compare pre and post events regarding Hong Kong.

6. AVAILABILITY OF DATA AND MATERIAL

Used or generated data already present in this study.

7. REFERENCES

- Bednarek, M., & Caple, H. (2017). The Discourse of News Values How News Organizations Create Newsworthiness. *Journal of Experimental Psychology: General*, 136(1), 23–42.
- Bennett, W. L. (2003). Operation perfect storm: The press and the Iraq War. *Political Communication Report*, 13(3).
- Dawn. (2019a, October 9). *PM Imran, President Xi discuss bilateral relations*. Retrieved from <https://www.dawn.com/news/1509886/pm-imran-president-xi-discuss-bilateral-relations>

- Dawn. (2019b, October 11). *PM calls out international media for “ignoring dire human rights crisis” in occupied Kashmir*. Retrieved from <https://www.dawn.com/news/1510260>
- Edward, S. (1993). *The media 's role in U . S . foreign policy*.
- Eijaz, A. (2012). Media Affecting Upon or Affected By Foreign Policy : The Case of Pakistan. *Journal of Alternative Perspectives in the Social Sciences, Volume 5 N*(January 2012), 74–95.
- ENTMAN, Robert. (1993). Framing: Toward a clarification of a fractured paradigm. *Journal of Communication, 43*(3), 51–58.
- Entman, R. M. (2007). Framing bias: Media in the distribution of power. *Journal of Communication, 57*(1), 163–173. <https://doi.org/10.1111/j.1460-2466.2006.00336.x>
- Fahmy, S., & Eakin, B. (2014). High drama on the high seas: Peace versus war journalism framing of an Israeli/Palestinian-related incident. *International Communication Gazette, 76*(1), 86–105. <https://doi.org/10.1177/1748048513504046>
- Fahmy, S., & Neumann, R. (2012). Shooting War Or Peace Photographs? An Examination of Newswires' Coverage of the Conflict in Gaza (2008-2009). *American Behavioral Scientist, 56*(2), NP1–NP26. <https://doi.org/10.1177/0002764211419355>
- Forgette, R., & Morris, J. S. (2006). High-conflict television news and public opinion. *Political Research Quarterly, 59*(3), 447–456. <https://doi.org/10.1177/106591290605900312>
- Galtung, J. (1986). On the role of the media in worldwide security and peace. In *Peace and Communication* (pp. 12–34).
- Galtung, J. (2003). Peace Journalism. *Media Asia, 30*(3), 177–180. <https://doi.org/10.1080/01296612.2003.11726720>
- Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Retrieved from <https://psycnet.apa.org/record/1975-09476-000>
- Hussain, I. (2015). News Framing on Indo-Pak Conflicts in the News (Pakistan) and Times of India: War and Peace Journalism Perspective. *Journal of Mass Communication & Journalism, 05*(08). <https://doi.org/10.4172/2165-7912.1000272>
- Jakobsen, P. V. (2000). Focus on the CNN effect misses the point: The real media impact on conflict management is invisible and indirect. *Journal of Peace Research, 37*(2), 131–143. <https://doi.org/10.1177/0022343300037002001>
- Lasorsa, D. L. (1997). Communication and democracy. Exploring the intellectual frontiers in agenda-setting theory. In *Chapter-11: Media Agenda setting and press performance: A social system approach for building theory* (1st ed.). <https://doi.org/10.4324/9780203810880>
- Lee, S. T. (2010). Peace journalism: Principles and structural limitations in the news coverage of three conflicts. *Mass Communication and Society, 13*(4), 361–384. <https://doi.org/10.1080/15205430903348829>
- Lee, S. T., & Maslog, C. C. (2005). War or peace journalism? Asian newspaper coverage of conflicts. *Journal of Communication, 55*(2), 311–329. <https://doi.org/10.1093/joc/55.2.311>
- Lynch, J., & McGoldrick, A. (2014). What is Peace Journalism? *Activate*, (Winter 2001), 6–9.
- Ma, N. (2007). Political development in Hong Kong : State, political society, and civil society. In *Political Development in Hong Kong : State, Political Society, and Civil Society*. <https://doi.org/10.5790/hongkong/9789622098107.001.0001>
- Maslog, C. C., Lee, S. T., & Kim, H. S. (2006). Framing analysis of a conflict: How newspapers in five

asian countries covered the iraq war. *Asian Journal of Communication*, 16(1), 19–39. <https://doi.org/10.1080/01292980500118516>

McCombs, M., Llamas, J. P., Lopez-Escobar, E., & Rey, F. (1997). Candidate images in Spanish elections: Second-level agenda-setting effects. *Journalism and Mass Communication Quarterly*, 74(4), 703–717. <https://doi.org/10.1177/107769909707400404>

Munawar, R. (2015). *Image Framing of Pakistan in China : A Case Study of Xinhua News Agency Munib Ahmed*, PhD Scholar Communication University of China, Beijing Rehana Munawar Communication University of China, Beijing Abstract. (1), 2–14.

Nadeem, M. U., & Khan, M. A. (2017). Pakistani print media and Taliban: A test of media conformity theory. *VFAST Transactions on Education and Social Sciences*, 13(2), 1–6.

Neuendorf, K. A. (2017). The Content Analysis Guidebook. In *SAGE Publications* (2nd ed.). Retrieved from <http://us.sagepub.com/en-us/nam/the-content-analysis-guidebook/book234078>

Nye, J. S. (2002). Limits of American Power. *Political Science Quarterly*, 117(4), 545–559. <https://doi.org/10.2307/798134>

Parker, E. B., & Holsti, O. R. (1970). Content Analysis for the Social Sciences and Humanities. *American Sociological Review*, 35(2), 356. <https://doi.org/10.2307/2093233>

Peng, Z. (2004). Representation of China: An across time analysis of coverage in the New York Times and Los Angeles Times. *Asian Journal of Communication*, 14(1), 53–67. <https://doi.org/10.1080/0129298042000195170>

Ramasubramanian, S., & Miles, C. (2018). Framing the Syrian Refugee Crisis: A Comparative Analysis of Arabic and English News Sources. *International Journal of Communication*, 12, 19.

Rawan, B., Hussain, S., & Khurshid, A. (2018). Media Framing and Foreign Policy : A Case Study of the Coverage of Sino-Pak Relations in Global Media. *The Dialogue*, XIII Numbe, 10.

Raza, M. R., & Aziz, S. F. (2012). Portrayal of war on terrorism in pakistani print media exploring peace framing in daily nation and business recorder. *Asian Journal of Social Sciences and Humanities*, 1(4), 97–108.

Scheufele, D. A. (1999). Framing as a theory of media effects. *Journal of Communication*, 49(1), 103–122. <https://doi.org/10.1111/j.1460-2466.1999.tb02784.x>

Shinar, D. (2004). *Media Peace Discourse: Constraints, Concepts and Building Blocks*. 3(1), 1–8.

Siraj, S. A. (2010). Framing War and Peace Journalism on the Perspective of Talibanisation in Pakistan. *Media Asia*, 37(1), 13–20. <https://doi.org/10.1080/01296612.2010.11771971>

Sparks, C. (2010). Coverage of China in the UK national press. *Chinese Journal of Communication*, 3(3), 347–365. <https://doi.org/10.1080/17544750.2010.499637>

Vreese, C. H. (2005). News framing: Theory and typology Information Design. *Information Design Journal + Document Design*, 13(1), 51–62. <https://doi.org/10.1075/idjdd.13.1.06vre>

Wang, Y. (2019). Local identity in a global city: Hong Kong localist movement on social media. *Critical Studies in Media Communication*, 1–15. <https://doi.org/10.1080/15295036.2019.1652837>

Wilke, J., & Achatzi, J. (2011). From Tian'anmen Square to the global world stage: Framing China in the German press, 1986–2006. *Chinese Journal of Communication*, 4(3), 348–364. <https://doi.org/10.1080/17544750.2011.594563>

Wimmer, R. D., & Dominick, J. R. (2000). *Mass Media Research: An Introduction*, 6th edition.

- Yousaf, S. (2015). Representations of Pakistan: A framing analysis of coverage in the U.S. and Chinese news media surrounding operation Zarb-e-Azb. *International Journal of Communication*, 9(1), 3042–3064. Retrieved from <http://ijoc.org/index.php/ijoc/article/view/3556>
- Yousaf, Z., Zia, A., & Ali, E. (2014). Portrayal of Pak-China Relations in Elite Press of Pakistan, China, India and the United States. *Middle-East Journal of Scientific Research*, 22(6), 870–878. <https://doi.org/10.5829/idosi.mejsr.2014.22.06.21969>
- Zaheer, L. (2017). Editorial Coverage of Kashmir Conflict in Pakistani Media. *Pakistan Vision*, 18(1), 47–56.
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INTERACTIVE EFFECTS OF WORKPLACE SPIRITUALITY AND JOB AUTONOMY WITH ORGANIZATION-BASED SELF-ESTEEM ON ORGANIZATIONAL LEARNING CULTURE

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ABSTRACT

Learning has assumed a key factor in the success of organizations. There is an ongoing debate among academics and practitioners alike about real essence of learning and its determinants. In this study, the main purpose is to examine the role of organizational-based self-esteem as one enabler of organizational learning culture. A model has been proposed to scientifically analyze the moderating effects of workplace spirituality and job autonomy between organizational-based self-esteem and organizational learning culture. Employees from private security companies participated in this research and linear regression analyses along Process Macro executed in SPSS® are used to test hypotheses. This research positions workplace spirituality and job autonomy in learning culture debate and implies that learning can be enriched by attending to spiritual enrichment and autonomous jobs. The research suggests a significant relationship between organizational-based self-esteem and organizational learning culture, whereas moderation by workplace spirituality is not proven.

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1. INTRODUCTION

Personal and Organizational values are considered highly relevant in organizational settings and any inconsistency among these values may lead to results that are detrimental to the larger interest of both employees and organization. Incongruence in values also poses a sizable threat to self-esteem of employees which merits attention due to its strong explanatory power including associated learning and other positive outcomes (Yang, 2015). Self-Esteem has emerged as an area of interest for researchers while focusing on the organizational, community, interpersonal, and individual

effects (Gardener & Pierce, 2011).

It may not be possible to ensure optimal performance while undermining actual abilities, competence, and importance of individuals in organizational settings. When an individual is accorded value that is true to his/her beliefs; a feeling of *I count around here* is ingrained, which is one essential tenet of organizational-based self-esteem (OBSE). Such employees who associate high degree of value and meaningfulness with themselves exhibit engaging behaviors for organizations (Korman, 1971).

Nowadays, organizations stress has become a common phenomenon, whereas employees high in organizational based self-esteem show composure against external stressors and negative information. Hence, positive organizational outcomes including intrinsic motivation, commitment and learning behaviors are determined by OBSE (Arshadi & Damiri, 2013). The capacity to produce these worthwhile outcomes by OBSE has brought this topic under sharp focus of researchers. Learning behavior is prime determinant of organizational learning culture (OLC) which is supportive for continuous learning for all members of the organization who are the ultimate architects of competitive advantage. Ongoing competitive environments warrant novel techniques to achieve competitive advantage (Hung et al., 2010). (Hislop, 2010) stated that numerous practices, activities and values are instrumental towards creation of learning culture. In this regard organizational based self-esteem is also found to be related with high level of performance (Gardner, 1998). Organizational learning culture can prevail across the organization through individuals who are high in OBSE. These employees are likely to be high in motivation, productive and will display satisfaction. Through OBSE first-hand descriptions of behavior can be acquired instead of causes leading to behavior, therefore it extends novel insights into human behavior (Pierce et al., 1993). Numerous theories in the extant literature lend credence to these effects of OBSE which include self enhancement motivation theory (Dipboye, 1977), Cognitive consistency theory (Korman, 1970) and self-protection theory (Korman, 2001). All these theories suggest that individuals with high OBSE tend to engage in behaviors through which positive self-image is reinforced.

Culture deemed supportive of learning by employees leads to consistency among values held strong by employees and goals of organization. On the other hand, those environments which run contrary to the actual spirit of learning lead to undermining of employees values (Berson et al., 2015).

In their recent study (kokkinos & Voulgaridou, 2018) collected sample from school students concluded that those individuals who have high self - esteem along with intrinsic motivation are likely to respond positively to learning strategies, whereas the direct link was found to be insignificant. These findings lead to the conclusion that OBSE alone cannot substantiate a linkage with learning culture, which creates a void warranting further exploration of the phenomenon. Although in the past, efforts have been made to understand the phenomenon but studies treating OBSE as one key factor that may influence essential work-related outcomes could not be traced, hence being addressed in this study.

This study explores the link between OBSE and OLC while collecting a sample from private security guards. Private security industry is playing a critical role towards improving overall law and order situation in Pakistan. It has range of functions that include protection to employees, infrastructure and personal security. Despite immense contribution to society, it is not been able to

attract the attention of researchers. Hence, numerous problems faced by employees associated with this industry remain unresolved (Strom, et al., 2010). Most of these companies do not follow the labour law which deprives the employees from their rights. Appropriate Human resource mechanisms including training and recruitment are almost non-existent. Hence, present practices of security companies are disproportionate to the magnitude of task they are assigned. To regulate the functions of these security companies a central body has been established called All Pakistan Security Agencies Association, mainly to standardize the practices conforming to code of conduct but this organization is also without an powers to ensure compliance (Sehgal, 2014).

Moreover, to crystallize the findings, it also becomes imperative to understand the process through which this effect is taking place and circumstances under which the effect is operating (Hayes, 2018) purpose, the findings of Dreyer and Hermans (2014) were considered relevant and pertinent where it was stated that people must have full awareness about themselves along deep sense of purpose which becomes consistent with definition of workplace spirituality (WPS) which fulfills an individual's need for delight, meanings and esteem. Hence, it becomes pertinent to include WPS in this study as moderator, which is consistent with the findings of James et al. (2011) who suggested to examine the impact of workplace spirituality on variety of variables to further crystallize the concept and enabling the managers to follow a business model that creates space for employees to work while adhering to their respective beliefs. Maltby et al., (1999) argued that WPS is likely to assume an important role to predict OBSE, which leads to mitigate stress and also predicts satisfaction and wellbeing. According to James et al. (2011), spirituality has a central role in workplace which needs to be fully understood by employers. Fostering WPS in organizations by employers facilitates establishing highly functional environments for work, which promotes connectedness, sense of purpose and amicable relationships between employees, which further substantiates inclusion of this construct as moderator.

Additionally, providing some liberty in decision making to the employees results in alleviation of the impacts created by job demands and keep the employees engaged and motivated. Through the sense of involvement, perception of personal enhanced level is created which is considered imperative towards coping with job demands. It becomes consistent with the concept of job autonomy (JA) which is the freedom given to employees to make decisions in the job. Such employees make dedicated efforts to meet emerging challenges whereas, imposing excessive controls runs contrary to the interest of organization (Liu et al., 2011). The relevance of JA and WPS established by these arguments merited exploration of their impact in this study on the relationship between OBSE and OLC. This research is also crafted with a goal of laying a foundation for future knowledge development in the domain of self- esteem while exploring its connections with other variables.

2. LITERATURE REVIEW

The creation of new ideas and knowledge is a skill that should be honed to perfection for the survival of organizations. Even if new ideas or knowledge are not an immediate requirement of organization, the process merits recognition where knowledge repository is created while keeping it readily available for each organization member to meet future requirements. It is not in the realm of

possibility to find immediate results from creation of new ideas, because new knowledge only gradually transforms an organization into a better outlook. Similarly, in the context of OLC useful knowledge is always retained and valued as precious commodity in one form or the other so that it may be of use at some point in time in future (Lyles, 2016). Banerjee, Gupta, and Bates (2016) also stated that in organizations where new ideas are not supported, cannot provide an environment for employees to share knowledge. Free flow of new ideas and knowledge sharing requires culture supportive of learning. OLC is considered as a concept which is close to learning environment or learning climate. In work environment there are certain attributes which can easily be observed and measured which are termed as organizational climate (Nikolova et al., 2014), whereas culture is made up of values and beliefs of individuals regarding organization (Schneider et al., 2013). The concept of OLC has been derived from learning organization which is said to prevail when learning is considered as an important tool for success of business (Schmitz, Rebelo, Gracia, & Tomas, 2014).

Personal adequacy is a feeling that is likely to develop in those individuals of the organization who are high in OBSE. It also strengthens the association of employees with the organization. Moreover, it also becomes pertinent to mention that employees who are identified as valuable and meaningful for organizations are likely to exhibit engaging behaviors while extending support for others and creating a supportive culture (Unal & Turgut, 2016). It is driving force for employees to discard behaviors that run contrary to the organizational interest (Whelpley & Mcdaniel, 2016). OBSE leads to promotion of desirable behaviors in organizations in addition to inhibition of negative behaviors, primarily due to predominant feelings of being valued in an organization.

While keeping in view these arguments it is assumed that employees with a high degree of OBSE will act in a way which is consistent with OLC. The first hypothesis is

H1: Organizational based self-esteem has a positive impact on an organizational learning culture.

At present day, organizations have redefined challenges for employees and employers alike, wherein work demands have assumed different outlooks. Now a day's people at an average spend more time at work while performing tasks that warrant added focus, dedication and commitment. Therefore, involvement of only body and mind towards work has become a trivial concept and needs to involve soul and spirit as well as assumed added significance (Schutte, 2016).

Due to the complexity of the construct, it is not possible to define WPS in some widely accepted terms (Fourie, 2014). One preferred terminology used by researchers for WPS is a meaningful workplace while considering WPS as an important determinant of meaningful workplace (Steenkamp & Basson, 2013). Spirituality can be regarded as feeling of deep-seated connection with others, self and universe which elevates personal awareness. Moreover, the domain of spirituality is different from religion, therefore it can be stated that an individual may not be necessarily religious to practice spirituality. It is about an individual's logical needs for delight, adoration and meaning (Dreyer & Hermans, 2014). WPS is related to advantageous outcomes for organizations and with provision of opportunity for spiritual growth chances of better performance increase manifolds. It has also been found that given the high degree of self-awareness, employees tend to remain satisfied and happy despite all odds of job pressures (Kalita, 2015).

Spirituality is being discussed by employees in an informal way and considered to be a part of

their efforts to accomplish the tasks (Grant et al., 2004). In the past efforts have been made to understand Workplace Spirituality, but taking it as key factor towards important outcomes related to work is a missing link. The challenge is to accommodate the spiritual needs without compromising the organizations' operational brilliance (James et al., 2011).

Spirituality has a pivotal role in promoting OBSE which leads to countering stress positively. Additionally, it also predicts well-being and satisfaction (Maltby et al., 1999). WPS surfaces from interactive effects of personal actions, personality traits and organizational features, paying attention to organizational cultures and contexts which act as spirituality fostering and friendly environments. Moreover, in environments that are supportive of learning, spirituality of individuals is respected, nurtured and corresponds to values of organization. Simply stating WPS has an association with OLC (Tombaugh et al., 2011). Hence, next hypothesis of study is

H2: Workplace spirituality has a positive impact on an organizational learning culture.

Those aspects of the job that facilitate achieving meaningful goals related to work are called job resources. To handle effectively certain job demands these job resources have proven their effectiveness (Nahrgang et al., 2011). Job autonomy is one instance of job resource and reflects the liberty provided to employees in taking certain decisions and scheduling of work. With autonomy in job individuals willingly make endeavors to pursue tasks that otherwise deem beyond the scope of the organization (Morgeson & Humphrey, 2006). Job Autonomy is one case of job resource which shows the freedom towards performing certain tasks and decision making (Hackman & Oldham, 1976).

While keeping these arguments in view it becomes pertinent to test the hypothesis,

H3: Job autonomy has a positive impact on organizational learning culture.

Moreover, WPS is considered as a construct with strong explanatory power with positive influence on work-related outcomes (James et al., 2011). Spirituality is continuously evolving debate and has become central to organizational thinking process. Hence, time is ripe to bring spiritual realities under open discussion (Howard, 2002). Seeing the necessity to grasp the process (Hayes, 2018) through which OBSE is influencing OLC it may be assumed that WPS and JA will moderate the relationship between OBSE and OLC. Therefore, this discussion logically converges into next two hypotheses as following,

H4: Workplace spirituality moderates the relationship between organizational based self-esteem and organizational learning culture such that the high WPS will strengthen the relationship.

H5: Job autonomy moderates the relationship between organizational based self-esteem and organizational learning culture such that the high WPS will strengthen the relationship.

3. CONCEPTUAL MODEL

This study uses the model framework given in Figure 1. The basic statistics is used to explain the relationships between workplace spirituality (WPS), job autonomy (JA), organizational-based self-esteem (OBSE), organizational learning culture (OLC).

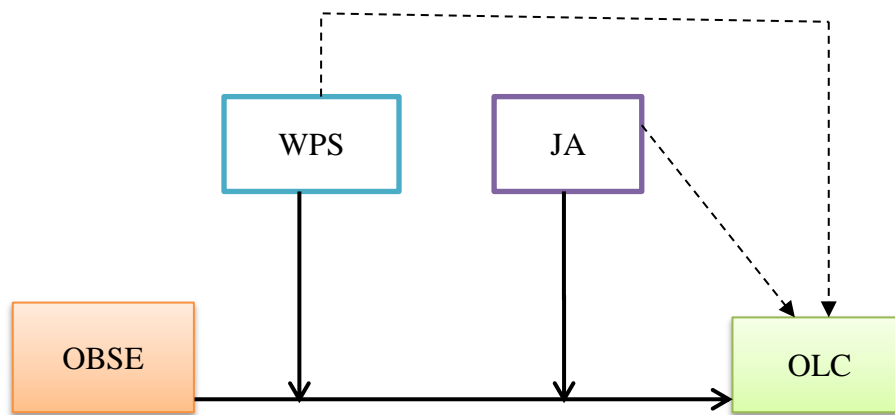


Figure 1: Model of organization-based self-esteem and organizational learning culture relationships.

4. METHODOLOGY

A self-administered questionnaire was used for the purpose of collecting data for this study while employing a convenience sampling method. It enabled the researcher to reach maximum numbers of respondents in limited time. Acquiring information on variables of interest from employees of private security companies was main goal of data collection process. All items were measured on five-point Likert scale ranging from strongly disagree to strongly agree except demographic ones.

The focus of this study was on the corroboration of envisaged relationships; therefore hypotheses are tested while making use of regression analysis and PROCESS macro implemented in SPSS.

4.1 SAMPLE CHARACTERISTICS

An aggregate of 674 questionnaires could be retrieved from 1300 questionnaires which were distributed. This response rate 51.84 % is taken as acceptable because minimum standards to this effect are not established (Johnson & Owens, 2003). These participants 10 % were from supervisory and managerial positions whereas 90% were security guard in security companies. The ages of respondents ranged from 20 to above 60 years. The majority was found within the age bracket of 21-30 years. In a sample, a total of 48% employees had experience 6-10 years whereas and this percentage decreased in each successive bracket. Hence, attrition rate was at increase beyond 6-10 years of working. This pattern is worth studying in some future research.

Only six respondents figured out as master degree holders whereas 60.7% had education up to Matriculation level only. Moreover, it was also found that male employees were in the vast majority with only two found as females.

4.2 INSTRUMENTATION AND MEASURES

An instrument with demonstrated reliability and validity across regions comprising of ten questions introduced by Pierce et al. (1989) was considered appropriate to measure OBSE. To measure OLC a shorter version of Dimensions of Learning Organization Questionnaire (DLOQ) questionnaire was used which identifies OLC as construct with seven dimensions. The original questionnaire has 42 items that cannot be conveniently responded (Yang et al., 2004). For WPS, instrument comprising of six items was used. The scale was suitably adapted to match the requirements of study. This instrument was developed after consultations with leading businessmen and religious scholars (Anthony, 2009). Four items instrument was adopted from Korean employees' job stress scale to measure job autonomy (KOSHA, 2004). Cronbach's alpha statistics along with a

sample item respecting all constructs are shown in table1

Table 1: Reliability statistics

Construct/Sample item	Items	Source	Cronbach's alpha
OLC <i>My organization makes its lessons learnt available to all employees</i>	7	Marsick & Watkins (2003)	0.95
JA <i>I am able to schedule when I work</i>	4	Korea Occupational Safety and Health Agency (2004)	0.72
OBSE <i>I count around here</i>	10	Pierce et al. (1989)	0.73
WPS <i>I show patience with others</i>	6	Anthony (2009)	0.71

Coefficients of all variables have value more than 0.7 therefore considered reliable.

Common method bias (CMB) is the variance that is likely to surface due to measurement method instead of questionnaire being used (Bagozzi & Yi, 1991). To offset any such influence Harman's single factor test is used and factor variance remained 42.025 % which is acceptable. CMB has no influence on the data if variance is less than 50% (Roni, 2016).

5. RESULTS AND FINDINGS

Pearson correlations are calculated and given in Table 2. All values are found significant ($p < .001$) and in the expected directions. For this study, these correlation results do not lead to the acceptance of hypotheses. Descriptive statistics Table 3 reflects description of data while providing foundation for later analyses.

Table 2: Pearson Correlations

Variables	OLC	JA	OBSE	WPS
OLC	-			
JA	.507**			
OBSE	.526**	.811**		
WPS	.317**	.531**	.481**	

Note. ** Correlation found significant at $p < 0.001$ level (2_tailed)

Table 3: Descriptive Statistics

	Range	Minimum	Maximum	Sum	Mean	SD
OLC	4.00	1.00	5.00	2502.29	3.718	.108
JA	3.75	1.25	5.00	2722.00	4.045	.707
OBSE	3.90	1.10	5.00	2778.40	4.128	.677
WPS	3.17	1.83	5.00	2717.67	4.044	.580

To determine essentially required consistency of model with data, Confirmatory Factor Analysis (CFA) was conducted while making use of various fit indices which indicated acceptable fit. Value of $\chi^2/df = 2.766(< 3)$, RMSEA = .051($\leq .08$) and SRMR = .038(≤ 0.05). Moreover, values of TLI, CFI and IFI are .903, .911 and .911 respectively while meeting the cutoff level ($\geq .90$). Similarly, all factors loadings ranged from 0.56 to 0.9, hence considered acceptable.

Regression analysis was carried out to test the direct hypothesis. It was found that OBSE has positive and significant impact on OLC ($\beta = 0.526$, $p < 0.001$). These results are reflected in Table 5. This finding lends credence to H1 of this study, hence stands accepted. Workplace Spirituality and job autonomy were also found to have positive and significant impact on OLC with results as ($\beta =$

0.317, $p < 0.001$) and ($\beta = 0.507$, $p < 0.001$) respectively (Tables 6 and 7). Therefore, H 2 and H 3 were accepted.

Last two hypotheses pertaining moderating effect were tested through model 1 in PROCESS MACROS 3 developed by Hayes (2017) in SPSS. According to next hypothesis WPS moderates the relationship between OBSE and OLC. Results were calculated at 95% confidence interval with 5000 bootstrapped samples in PROCESS MACROS 3 model 1. No signs of moderation figured out with insignificant interaction ($p > 0.05$) and zero between both limits of confidence interval (LLCI = -.06, ULCI = 0.32). Hence, H 4 of the study was rejected. On the other hand, job autonomy had significant moderating effect between OBSE and OLC ($p < 0.05$) and zero value also did not lie between limits of confidence interval (LLCI = 0 .0031, ULCI = 0.2453). Conditional moderation of job autonomy at values ranging from small to high was also significant. At the lowermost value (effect = .7011, $p < .05$) and point estimates also indicate that zero is not there between lower and upper limits of confidence interval (LLCI= .4712, ULCI = .9310). At intermediate level effect was again significant (effect = .7632, $p < 0.05$) without zero between the bounds of confidence interval (LLCI =.4908, ULCI = 1.0356). Similarly, at the uppermost value of Job Autonomy again significant impact was established (effect = .7942, $p < .05$) and further reinforced by non - existence of zero among lower and upper bounds (LLCI = .4983, ULCI = 1.0902) of confidence interval. These results lead to the acceptance of H 5 of the study. Moderation results are stipulated in Tables 8 and 9.

Table 4: Regression Analysis - OBSE and OLC (Dependent Variable: OLC)

Unstandardized Coefficients			Standardized Coefficients			
	B	Std. Error	Beta	t	F	Sig.
(Constant)	.162	.225				
OBSE	.861	.054	.526	16.029		<0.001
					257	<0.001

Table 5: Regression Analysis – WPS and OLC (Dependent Variable: OLC)

Unstandardized Coefficients			Standardized Coefficients			
	B	Std. Error	Beta	t	F	Sig.
(Constant)	1.268	.286				
WPS	.606	.070	.317	8.640		<0.001
					75	<0.001

Table 6: Regression Analysis – JA and OLC (Dependent Variable: OLC)

Unstandardized Coefficients			Standardized Coefficients			
	B	Std. Error	Beta	t	F	Sig.
(Constant)	.505	.214				
WPS	.794	<0.001	.507	15.22		<0.001
					231.663	<0.001

Table 7: Results of Moderation

Interaction	Coefficient	SE	t	P	LLCI	ULCI
OBSE x WPS Dependent; OLC	.13	.09	1.38	.17	-.06	.32
OBSE x JA Dependent; OLC	.1242	.0617	2.0131	.0445	.0031	.2453

Table 8: Conditional Effects at Various Values of Moderator – JA

Values of JA	Effect	SE	t	p	LLCI	ULCI
Low	.7011	.1171	5.9869	<0.001	.4712	.9310
Medium	.7632	.1387	5.5017	<0.001	.4908	1.0356
High	.7942	.1507	5.2691	<0.001	.4983	1.0902

6. DISCUSSION

This study explored the importance of organizational based self-esteem towards shaping the environmental context for learning and at the same time stimulating perception of employees that their lives and work have meaning. This enables the employees to harmonize efforts for integrating their energy and lives for work. This is in line with the findings of (Sorakraikitikul & Siengthai, 2014). The strong and positive impact of organizational based self-esteem on organizational learning culture as found in this study ($\beta = 0.526$, $p < .001$) indicates that individuals who are accorded value in organization and consider themselves meaningful, engage in behaviors which are in larger interest of organization and become an important determinant of learning culture. This lends credence to **H1** of this study. According to the results Workplace Spirituality has significant and positive impact on OLC ($\beta = .317$, $p < 0.001$), although the coefficient of regression is not very strong yet emerging significant while signaling a connection with organizational learning culture without any contradiction with extant literature. According to Howard (2002), spirituality has strong connections with learning capabilities and emotions, rather these are interwoven concepts. It is imperative for all humans to embrace spirituality and learning as core components of their personality. The same is true for organizations also where by virtue of learning employees may infer and take decisions about their actions in various circumstances which warrant courage. It is through deep seated relationship with spirituality that essentially required strength is mustered. Sorakraikitikul and Siengthai (2014) also explored strong association between workplace spirituality with organizational learning culture. These arguments are consistent with **H2** of this study.

Similarly, with organizational learning culture; Job Autonomy exhibited a positive and significant influence ($\beta = 0.507$, $p < 0.001$). Individuals entrusted with independent responsibilities with leverage to find solutions are more likely to engage in learning activities while contributing directly towards creation of learning culture which is consistent with previous research for example in a research undertaken by (Liopis & Foss, 2015) it was explored that employees with requisite autonomy given in their jobs are more inclined to knowledge sharing activities. Hence, acceptance of **H3** of this study is in line with the findings of previous studies on the subject.

Moderating effect of workplace spirituality between organizational based self-esteem and organizational learning culture was not significant while rejecting **H4**. Seeing the strong explanatory power of workplace spirituality and proven linkage with organizational based self-esteem and organizational learning culture; significant moderating effect was expected. Since Private security companies formed the population of this study which is not analyzed against the construct of workplace spirituality in the past, hence this may be one reason for the rejection of hypothesis. In some future research deep down processes through which these effects come to operation and specific boundary conditions of these effects in question may be explored.

Conversely, **H5** is supported because job autonomy has significant moderating effect between organizational based self-esteem and organizational learning culture. Moreover, conditional effects at different levels of job autonomy indicate that with job autonomy at maximum value the corresponding effect of organizational based self-esteem on organizational learning culture will increase which further crystallizes the importance of autonomous jobs. Although, the moderating

effect of job autonomy on the relation between organizational based self-esteem and organizational learning culture is not explored in the past, but positive influences on these two constructs are evident, hence findings of this research shall not be considered to contradict the extant literature.

7. CONCLUSION

The emphasis of this study was to examine the impact of organizational based self-esteem on organizational learning culture and exploration of the process by which the impact is taking place. All the specified objectives were achieved by testing five hypotheses. The results indicate that every employee serving in organization irrespective of position is important and feelings of being valued lead to shaping motivation, behaviors and work-related attitudes. Similarly, this research shows that construct of workplace spirituality is assuming added significance for organizations. Many employees have desire to lead lives according to spiritual demands and business leaders who are aware of spiritual path are making consistent efforts to refine their spiritual personality while focusing on the influence they have on organization and society as well. Therefore, it merits attention of academics and practitioners alike. In this research workplace spirituality did not figure out as moderator in the relationship between OBSE and OLC and cause may be traced in the provocative nature of the subject. Moreover, people are anxious and edgy about its inclusion in the domain of business and there lies a need to draw up boundaries in debates regarding spirituality to arrive at a rational viewpoint. From the perspective of learning culture; workplace spirituality figures out as leading indicators of performance which so far has been overlooked in the literature. In this study a learning culture has been identified as new context for job autonomy and workplace spirituality while creating new meanings for life and work. This study specifies the critical role of organizational learning culture as a mechanism towards development of employee values.

8. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

9. REFERENCES

- Anthony, J. V. (2009). Examining the relationship of spirituality and religiosity to individual productivity in the united states. *The dissertation submitted to North Central University, Graduate faculty of the school of Business and management in partial fulfillment of the requirements for the degree of PhD* . Prescott Valley, Arizona.
- Arshadi, N., & Damiri, H. (2013). The relationship of job stress with turnover intention and job performance: Moderating role of OBSE. *Social and Behavioural Sciences Journal*, 84, 706-710.
- Bagozzi, R. P., & Yi, Y. (1991). Multitrait-Multimethod matrices in Consumer research. *Journal of consumer research*, 17, 426-439.
- Banerjee, P., Gupta, R., & Bates, R. (2016). Influence of organizational learning culture on knowledge workers motivation to transfer training: testing moderating effects of learning transfer climate. *Journal of Curr Psychol*.
- Berson, Y., Da'as, R. A., & Waldman, D. A. (2015). How do leaders and their teams bring about organizational learning and outcomes? 68, 79-108.
- Dipboye, R. L. (1977). A critical review of Kormans self - consistency theory of work motivation and

occupational choice. *Organizational Behaviour and human Performance*, 18, 108-126.

- Dreyer, J. S., & Hermans, C. A. (2014). Spiritual character traits and leadership in the school workplace: An exploration of the relationship between spirituality and school leadership in some private and religiously affiliated schools in South Africa. *Koers Bulletin for Christian Scholarship*, 79(2), 8. doi:10.4102/koers.v79i2.2136
- Fourie, M. (2014). Spirituality in the work place: An introductory overview. In *Die Skriflig*, 1769, 8. doi:doi. org/ 10.4102/ ids.v48i1. 1769
- Gardener, D. G., & Pierce, J. L. (2011). A question of false self-esteem. *Journal of Managerial Psychology*, 26(8), 682-699.
- Gardner, D. G. (1998). A question of false self-esteem. *Group and Organizational Management Journal*, 23(1), 48-70.
- Grant, D., Neil, O., & Stephens, L. (2004). Spirituality in the work place: new empirical directions in the study of the sacred. *Journal of sociology of the Religion*, 65, 265-283.
- Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: test of theory. *Organizational Behaviour and Human Performance*, 16(2), 250-279.
- Hayes, A. F. (2018). Partial, conditional, and moderated mediation: Quantification, inference, and interpretation. *Communication Monographs*, 85(1), 4-40.
- Hislop, D. (2010). *Knowledge management in organizations (2nd ed.)*. Newyork: Oxford University Press. Inc.
- Howard, S. (2002). A spiritual perspective on learning in the workplace. *Journal of Managerial Psychology*, 17(3), 230-242.
- Hung, R. Y., Yang, B., Lien, B. Y., Mclean, G. N., & Kuo, Y. M. (2010). Dynamic capability: impact of process alignment and OLC on performance. *Journal of world business*, 45, 285-294.
- James, M. S., Miles, A. K., & Mullins, T. (2011). The interactive effects spirituality and trait cynicism on citizenship and counterproductive work behaviours. *Journal of Management, Spirituality and Religion*, 8(2), 165-182.
- Kalita, K. (2015). *A comparative study of spirituality and burnout among employees in different sectors*. Retrieved from www.Researchgate.net: www.Researchgate.net/ publication/308693073
- kokkinos, C. M., & Voulgaridou, I. (2018). Motivational beliefs as mediators in the association between perceived scholastic competence, self-esteem and learning strategies among Greek secondary school students. *Educational Psychology*. doi:10.1080/01443410.2018.1456651
- KOSHA (2004). Retrieved from Job stress measurement scale for Korean employees: Korea Occupational Safety and Health Agency. [http:// safedu.org/pds1/ 9633](http://safedu.org/pds1/9633).
- korman, A. K. (1970). Towards an hypothesis of work behaviour. *Journal of Applied Psychology*, 54, 31-41.
- Korman, A. K. (1971). Organizational achievement, aggression and creativity: some suggestions towards integrated theory. *Organizational Behaviour and Human Performance*, 6, 593-613.
- Korman, A. K. (2001). Self-enhancement and self-protection: Toward a theory of work motivation. Erlbaum: Mahwah.
- Korman, A. K. (n.d.). Self enhancement and self - protection: Towards a theory of work motivation. In M. erez, U. kleinbeck, & H. Thierry (Eds.) .

- Liopis, O., & Foss, N. J. (2015). Understanding the climate-knowledge sharing relation: The moderating rules of intrinsic motivation and job autonomy. *European Management Journal*. doi:doi.org/10.1016/j.emj.2015.11.009
- Liu, C., Spector, P. E., Liu, Y., & Shi, L. (2011). The interaction of job autonomy and conflict with supervisor in China and United States: a qualitative and quantitative comparison. *International Journal of Stress Management*, 18(3), 222-245.
- Lyles, M. A. (2016). Leveraging Organizational learning and alliances in complex and changing business environments. *Global Entrepreneurship Past Present and Future*, 5-17. doi:doi.org/10.1108/S1571-502720160000029002
- Maltby, J., Lewis, C. A., & Day, L. (1999). Religious orientation and psychological well being: the role of the frequency of personal prayer; religious orientation and psychological well- being. *British Journal of health psychology*, 4, 363-378.
- Marsick, V. J., & Watkins, K. E. (2003). Demonstrating the value of OLC: Dimensions of learning organizational culture. *Advances in Developing Human resources*, 5(2), 132-151.
- Morgeson, F. P., & Humphrey, S. E. (2006). the work design questionnaire(WDQ): Developing and validating a comprehensive measure for assessing job design and the nature of work. *Journal of Applied Psychology*, 91, 1321-1339.
- Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: ameta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, 96(1), 71-94.
- Nikolova, I., Russeveldt, J. V., Dewitte, H., & Dama, K. V. (2014). Learning climate scale: construction, reliability and initial validity evidence. 85, 258-265.
- Nikolova, S. M., Van, J. R., DeWitte, H., & Van, K. D. (2014). Learning climate scale: construction, reliability and initial validity evidence. *Journal of vocational behaviour*, 85, 258-265.
- Pierce, L. J., Gardner, D. G., & Dunham, R. B. (1993). Moderation by organization based self-esteem of role condition-employee response relationships. *Academy of Management Journal*, 36, 271-288.
- Pierce, L., Gardner, D. G., Cummings, L. L., & Dunham, R. B. (1989). Moderation by OBSE: construct definition, measurement, and validation. *Academy of management Journal*, 622-648.
- Roni, S. M. (2016). *What is meant by common method bias? How do we test and control it?* Retrieved from <http://www.researchgate.net/post>
- Schmitz, S., Rebelo, T., Gracia, F. J., & Tomas, I. (2014). Learning culture and knowledge management process: To what extent are they effectively related? *Journal of Work and organizational Psychology*, 30, 113-121.
- Schneider, B., Ehrhart, M. G., & Macey, W. H. (2013). Organizational climate and culture. *Annual review of Psychology*, 64, 361-388.
- Schutte, P. J. (2016). Workplace spirituality: A tool or a trend? *HTS teologiese Studies/ Theological Studies*, 72(4), 3294. doi:doi.org/10.4102/hts.v72i4.3294
- Sehgal, I. (2014). *Regulating Pakistan,s private security industry*. Retrieved from [http:// viewsworld.com/viewsworld-exclusive/regulating-Pakistans-security-industry](http://viewsworld.com/viewsworld-exclusive/regulating-Pakistans-security-industry)
- Sorakraikitikul, M., & Siengthai, S. (2014). OLC and workplace spirituality, is knowledge sharing behaviour a missing link? *The Journal of Learning Organization*, 21(3), 175-192.
- Steenkamp, P. L., & Basson, J. S. (2013). A meaningful work place: Framework, space and context. *HTS Teologiese studies/ Theological Studies*, 1258.

- Strom, K., Berzofsky, M., Shook-Sa, B., Barrick, K., Daye, C., Horstmann, N., & Kinsey, S. (2010). *The Private security industry: A review of the definitions, available data sources, and paths moving forward, literature review and secondary data analysis*. 3040 Crnwallis road Research Triangle Park, NC 27709: RTI International.
- Tombaugh, J. R., Mayfield, C., & Durand, R. (2011). Spiritual expression at work: exploring the active voice of workplace spirituality. *international Journal of Organizational Analysis*, 19(2), 146-170.
- Unal, Z. M., & Turgut, T. (2016). Organizational culture and organizational based self- esteem as predictors of spirit at work. *Khazar Journal of Humanities and Social Sciences*, 19(4), 71-96.
- Whelpley, C. E., & Mcdaniel, M. A. (2016). Self-esteem and counterproductive work behaviours: A systematic review. *Journal of Managerial Psychology*, 31, 850-863.
- Yang, B., Watkins, K. E., & Marsick, V. J. (2004). The construct of learning organization: Dimensions, measurement, and validation. *Human Resource Development Quarterly*, 15(1), 31-55.
- Yang, C. C. (2015). The integrated model of core competence and core capability. *Total Quality Management and Business Excellence*, 26, 1-17.

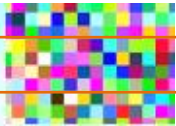


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EXPLAINING AND DESIGNING OF MANPOWER PRODUCTIVITY MANIFESTATION MODEL AT SADERAT BANK OF IRAN: CASE STUDY OF CENTRAL STAFFS

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ABSTRACT

This study used a structural model to explain and design the model of manpower productivity effects in Saderat Bank of Iran, a case study of Central Headquarters. For data collection and methodology, it is descriptive-correlation research. The sample size consisted of 360 employees of Saderat Bank of Iran selected by stratified random sampling. Data analysis was performed using SPSS and confirmatory factor analysis was performed using AMOS software. The results showed that there is a positive and significant relationship between organizational related factors and manpower productivity effects in Saderat Bank of Iran. There is a positive and significant relationship between the characteristics of individuals' attitudes and manpower productivity effects in Saderat Bank of Iran. Finally, organizational related factors with the characteristics of individual attitude in Saderat Bank of Iran have a positive and significant mutual relationship. Therefore, by providing appropriate strategies and planning to meet these components, organizational related factors and individual attitude of human resources can be strengthened and subsequently enhanced human resource productivity effects.

Disciplinary: Management Sciences (Human Resources Management).

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1. INTRODUCTION

Manpower is the main capital of the modern age organization. Employees are increasingly contributing to the goals and functions of the organization (Rosiek et al., 2016: 24). Without efficient people, it is impossible to achieve organizational goals (Shapira, 2014: 676).

In the current era, like other institutions, government management faces many challenges in improving productivity that is due to developments in cultural, social, economic and political spheres. Extremely technological innovations, knowledgeable of organizations, globalization, diversification and cultural diversity, reducing public confidence in public institutions, and so on are the most significant changes that have made uncertainty about the performance and efficiency of public administration. In fact, productivity as a philosophy and vision based on improvement strategy considered to be the most important goal in any organization which can act as a chain of activity for all sectors of society so that, the mission of management and the main purpose of managers of each organization is efficient and optimal use of various forces and facilities such as labor, capital, materials, energy and information (Kudyba et al, 2003: 21).

Therefore, the most important responsibility of managers is to adapt their managed complex to environmental changes and improve its productivity to provide better quality services in order to satisfy citizens' satisfaction and expectations (Attar et al., 2012: 12).

But authors of the field, such as Souter Meister, Murray Ainsworth et al. (2002); Hersey Goldsmith (1980) almost agree that there can be only one specific cause for the increase in productivity, but that productivity promotion must be considered a combination of different factors. Most of these studies have provided reasons for greater productivity in organizations. In fact, each of these components can examine the productivity of human resources according to their dimensions and sub-components, to some extent to cover research weaknesses in the area of non-functional dimensions (Nardi & Schwars, 2012).

Since productivity effects are not only considered as benchmarks and tools of economic activity, they are also considered strategically and important competitive advantages. Because it paves the way for achieving goals and strategies by identifying the critical points and tools used.

It should be noted that the concept of productivity effects is not limited and in addition to features such as various aspects of spiritual life and development of individual goals and needs. Therefore, productivity effects are a broad concept of economic, managerial, social, and so on and cannot be limited. Productivity effects lead to organizational intelligence and put the organization on the strategic path (Hanaysha & Tahir, 2016: 277).

In the context of scientific necessity, many scholars have been explored and explained the reasons of promoting productivity, among these, one can mention the scholarly studies such as Souter Meister, Murray Ainsworth et al. (2002), Hersey Goldsmith (1980), Gangspadhyay et al. (2006), Lverson & Zatzick (2011),

Memarzadeh et al. (2017) also investigated the factors affecting the productivity of employees in a military health care organization. Baradaran & Valligani (2016) in a study entitled " investigating the effective factors on promoting manpower productivity in the Tax Affairs Organization of Iran" (a case study of East Tehran tax Administration) and found that three organizational factors, namely, personal and environmental attributes, respectively, have the most impact on productivity improvement. Shojaei and colleagues (2016), in a study, sought to identify factors influencing the productivity of manpower. Mirkamali and Ashob (2016), investigated the relationship between spiritual intelligence and productivity of artistic-cultural organization staff of Tehran municipality. Taghizadeh (2016) conducted a survey entitled "empowerment activity model aimed at promoting the productivity of employees in small and medium industries".

Omidi et al. (2016) investigated factors affect the productivity of police force manpower using

multi-dimensional decision making. Baladehi and Inejad (2016) investigate the leadership style of managers and their impact on promoting the productivity of manpower of police chiefs of Mazandaran Province. Aghani and Aghaee (2015) investigated factors affecting manpower productivity using the BSC model. Iranzadeh (2018) investigated the effect of knowledge management components on or manpower productivity using factor analysis methods in financial and credit institutions of Tabriz province. Paradi and colleagues (2016) examined the effects of integration and property right on Spanish manpower productivity. Guo et al. (2016) investigated the impact of structural activities of productivity on the stress and burnout of nurses in China. Hanaysha and Tahir (2016) investigated the impact of employee productivity on organizational commitment. Appelbaum et al. (2015) identified and combined the main factors affecting the success and failure of manpower productivity activities in both macro and micro dimensions in organizations.

Akhtar et al. (2015) investigated the impact of designing the work environment on the productivity of Oman Bank employees.

Dobni (2004) designed a model for labor productivity divided organization services into two parts of the trading and exchange features into the services and segmented market strategies or services.

Despite investigating the impact of various factors on employee productivity and research on different aspects of productivity models it seems that no progress has been made in explaining and designing the model of manpower productivity effects. Therefore, further research into the effects of productivity is needed.

In the present study, it was attempted to investigate these relationships in Saderat Bank of Iran considering the following hypotheses:

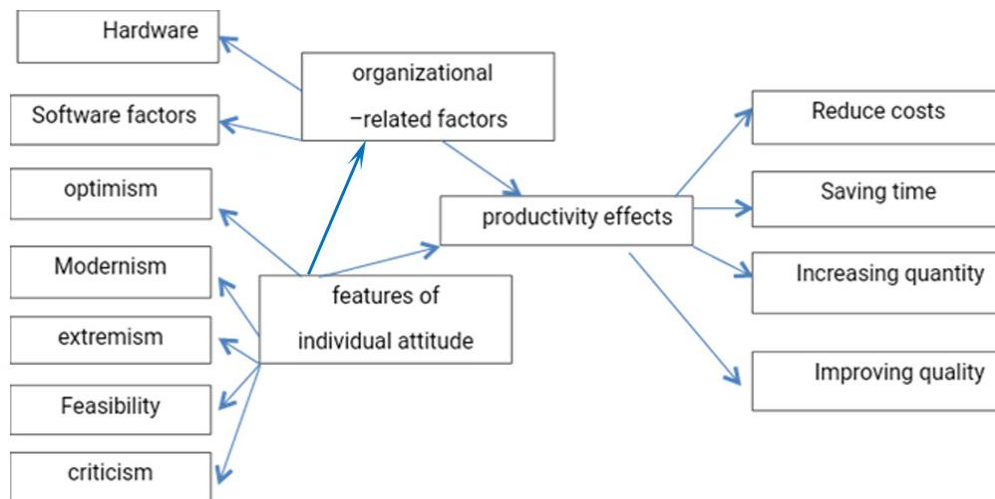


Figure 1: Conceptual Model of Research

2. RESEARCH METHODOLOGY

This research, in terms of the purpose, is exploratory combinatorial research and in terms of data collection and method of work is inductive- deductive. A total of 360 employees were selected as the sample. The method is stratified random sampling. The quantitative data collection tool was a researcher-made questionnaire based on the results obtained in the qualitative section. The researcher developed three questionnaires on Productivity Effect, Organizational Factors, and Individual Attitudes variables with five questions, based on the theoretical foundations and content

understanding of each component, and based on theoretical foundations and expert coordination. Content validity was used to quantify the content validity ratio (CVR) and content validity index (CVI). The results showed that the score of all 51 indices was higher than the Launch table number (0.42). These results indicate that the indices have acceptable statistical significance ($P < 0.05$). All CVIs of all 51 indices are above 0.79, so they were appropriately diagnosed. Cronbach's alpha coefficient was calculated using SPSS23 software as described in Table 1.

Table 1: Cronbach's Alpha Coefficients

Variables	No of Questions	Cronbach's Alpha Coefficient
Organizational Related Factors	14	0.89
Individual Characteristics	21	0.78
Productivity Effects	16	0.72
Total Questions	51	0.89

3. RESEARCH FINDING

To investigate, the assumption of the normal distribution of variables, before performing other analyzes, the standardization (normality) test in *AMOS₂₃* software was used to evaluate Skewness and Kurtosis of scales, to make the necessary conversions in case of intense Skewness and Kurtosis. If the Kurtosis and Skewness of the scales are less than 2, then there is no need for conversion, and the continuation of the statistical analysis process with these scales does not create a distortion in results (Tabachnick & Fidell, 2001). Based on the information in Table 2, the distribution of participants' scores on the research variables (organizational related factors, individual attitude characteristics, and manpower productivity effects) is shown. These scores are described by using appropriate descriptive statistics such as average, standard deviation and distribution indicators such as Skewness and Kurtosis.

Since Skewness and Kurtosis of the research variables are between ± 2 , the distribution of data is normal and indicates the desirability of the variable status for performing parametric analyzes and the use of structural equations.

Table 2: Descriptive indicators of latent variable and their components

Variables, Components	Average	Standard Deviation	Skewness	Kurtosis
Organizational related Factors	3.62	0.51	-1.14	1.83
Individual Attitudes	3.16	0.53	0.23	-0.58
Productivity Effects	2.73	0.56	0.46	0.07

4. RESEARCH HYPOTHESES TEST

Regarding the fact that in this study, two predictive variables namely, "organizational related factors" with two components including hardware factors and software factors and "individual attitudes", with five components including positivism attitude, modernity attitudes, (modernism), feasibility attitude, extroverted attitude (transcendence) and critical attitude and one criterion variable namely productivity effects with four components including reducing cost, saving time, increasing quantity and improving quality, a theoretical model in the structural model template is presented as follows:

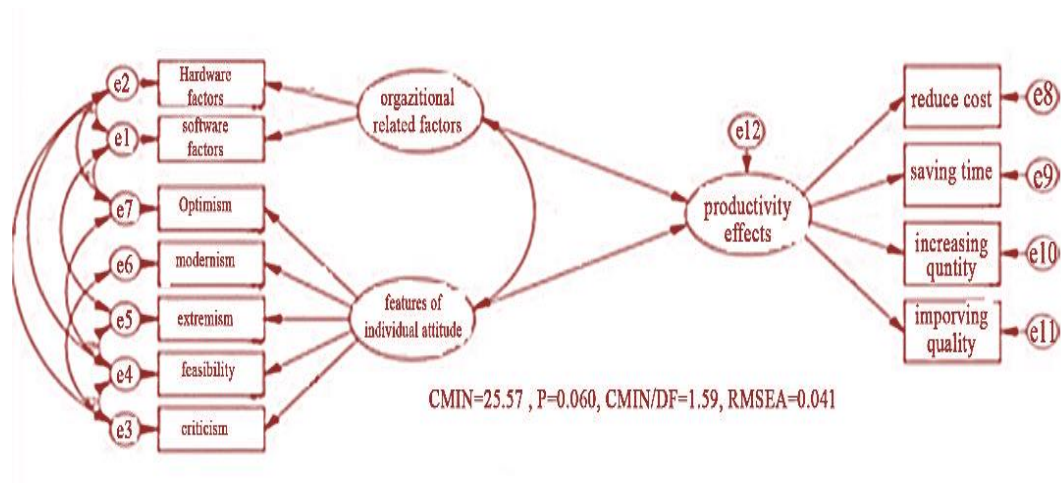


Figure 2: Research Structural Model

According to the results of Table 3, regarding the fit analysis of the model with respect to the fitness indices, it can be said that the factor analysis model has a good fit for answering the question and also testing the main hypotheses of the research. The model was used to explain and design the model of manpower productivity effects in Saderat Bank of Iran (Case Study of Central Headquarters). Table 3 gives a result of the goodness of fit index (GFI) (a measure of fit between the hypothesized model and the observed covariance matrix), the adjusted goodness of fit index (AGFI) (a correction to the GFI), Incremental Fit Index (IFI), the minimum discrepancy divided by its degrees of freedom (CMIN/DF), the root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker–Lewis index (TLI), and Normal Fit Index (NFI).

Table 3: Goodness of fit indices of the structural model of research variables

Fitness Indices of the Model	CMIN	DF	CMIN/DF	NPAR	P	GFI	AGFI	IFI	TLI	CFI	NFI	RMSEA
Fitted Model	25.57	16	1.59	50	0.060	0.99	0.95	0.99	0.98	0.99	0.98	0.041
Desirable Values	=df	-	< 3	-	>0.05	>0.90	>0.90	>0.90	>0.90	>0.90	>0.90	<0.08

The results of the above model test show that (Table 4) the relationship between organizational related factors and manpower productivity effects is positive and significant ($\beta=0.24$, $t= 9.83$, $p<0.05$). Also, the relationship between characteristics of individual attitude and manpower productivity effects ($\beta=0.45$, $t=5.09$, $p<0.05$) is positive and signification. Finally, the mutual relationship between organizational related factors and characteristics of individual attitude ($\beta=0.21$, $t=2.74$, $p<0.05$) is positive and significant.

Table 4: the relationship of hidden variables with each other

Path (Directions)	Path Coefficients			Significance level
	Standardized Parameter	Non-Standardized Parameter	T value	
Organizational related factors → productivity effects	0.24	0.32	9.83	0.001
Features of individual attitude → productivity effects	0.45	0.62	5.9	0.001
Organizational related factors → individual attitude	0.21	0.30	2.74	0.022

5. DISCUSSION

Since the beginning of human creation, man has always sought to maximize the use of available power considering the specific spatial and temporal limitations; therefore, the history of productivity should be linked to human history. Productivity is an indicator of effective, useful and efficient use of various forces. Productivity effects are one step ahead of the outflow ratio to inputs or average product produce per unit. In fact, productivity effects are the same as the positive effects that productivity can have on society, organization, groups and individuals.

Productivity effects are considered not only as a benchmark and tool for measuring the effectiveness of economic activities but also from a strategic perspective and an important competitive advantage. Because it paves the way for achieving goals and strategies by recognizing the critical points and the features and tools used. The important point is that manpower is the most important factor in improving productivity. In fact, human qualities are a kind of capital, because they can make our services more productive and ultimately more prosperous.

The results of the first hypothesis showed that there is a positive and significant relationship between organizational related factors and manpower productivity effects. In this regard, the managers of Saderat Bank of Iran have been able to implement an organizational structure and control the internal human resources so that they are able to respond to the business environment in a timely and appropriate manner. This research result consistent with the results obtained by Jafari & Memarzadeh (2018), Baradaran and Valijani (2017), Shojaei et al. (2017), Guo et al. (2016), Akhtar et al. (2015), Dobni (2004) and Hanaysha & Tahir (2016).

The second result showed that there is a positive and significant relationship between the characteristics of individual attitude and manpower productivity effects in Saderat Bank of Iran. Whereas among the factors of production, the factor of manpower, unlike other forces, has a high level of understanding and influence on the better use of other factors of production, in other words, it is the most important lever in increasing and decreasing the productivity of organizations. Therefore, it has a special place in the improvement of productivity and should be given special attention. The role of manpower in enhancing the efficiency of service organizations becomes more important due to the direct production and delivery of services by human resources. Applying motivated, empowered and productive manpower, in addition to providing efficient services, can utilize other intra-organizational forces efficiently and effectively, accomplishing all aspects of productivity and ultimately benefiting the organization. This result is consistent with the results of Jafari and Memarzadeh Tehran (2017), Baradaran and Valijani (2016), Taghizadeh (2016) and Omid et al. (2016), have been consistent.

6. CONCLUSION

Based on the research findings, it can be observed that there is a mutual relationship between organizational related factors and the characteristics of individual attitude in Saderat Bank of Iran. The reason for this mutual relationship can be interpreted as having a direct and dynamic impact on the individual attitude, nervous and mental readiness of the employees of the Saderat Bank through the experience of the organization and their response to all issues and situations related to the bank. On the other hand, the managers and supervisors of these banks have been successful in dividing, organizing and coordinating organizational activities and have created structures that coordinate the activities and control the work of the members. The organizational structure of the Saderat Bank has

been able to specify how tasks are to be assigned, whom to report to, and what are the formal coordination mechanisms, as well as the interactive organizational models to be followed. Therefore, the attitudes of the personnel and the organizational structure of Saderat Bank have had a mutual relation. No research has been found to investigate the mutual relationship between organizational related factors and the characteristics of the individual attitude

Based on the results of the research, considering the factors related to employee productivity through planning by policymakers and managers, it is necessary to provide more framework and appropriate mechanisms to improve employees' productivity.

7. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

8. REFERENCES

- Aghani, R., & Aghaee, M. (2015). Investigating factors affecting human resource productivity using the BSC Model. *Journal of Human Resource Management Researches At Imam Hossein University*, 4, pp.27-49.
- Ahmadi Baladehi, S. M., & Ebrahimnejad, S. (2016). Manager's leadership styles and its impact on promoting manpower productivity. *police development organizational quarterly, thirteenth*, 57, 61-85.
- Akhtar, N., Ali, S., Salman, M., & Ijaz, A. (2015). Interior Design and its Impact on Employees Productivity in Telecom Sector, Pakistan. *Journal of Asian Business Strategy*, 4(6), 74-82.
- Appelbaum, S. H., Karasek, R., Lapointe, F., & Quelch, K. (2015). Employer powerment: factors affecting the consequent success or failure (Part II). *Industrial and Commercial Training*, 47(1), 23-30.
- Attar, A. A., Gupta, A. K., & Desai, D. B. (2012). A Study of Various Factors Affecting Labour Productivity and Methods to Improve It. *Journal of Mechanical and Civil Engineering, Second International Conference on Emerging Trends in Engineering (SICETE)*, 11-14.
- Baradaran, V., & Valijani, M. (2017). Investigating the factors affecting the promotion of manpower productivity in the organization of tax Affairs of the country (case study of East Tehran Tax Affairs Administration), *Tax Revenue Research*, 29, 165-184.
- Dobni, D. (2004). A marketing-relevant framework for understanding service worker productivity. *Journal of Services Marketing*, 18(4), 303-317.
- Gangspadhyay, S., Das, T., Ghashal, G., Ghash, T. (2006). Work organization insand core manufacturing for health and productioivity. *International Journal of Industrial Ergonomics*, 36(10), 915-920.
- Guo, J., Chen, J., Fu, J., Ge, X., Chen, M., & Liu, Y. (2016). Structural empowerment, job stress and burnout of nurses in China. *Applied Nursing Research*, 31, 41-45.
- Hanaysha, J., & Tahir, P. R. (2016). Examining the effects of employee empowerment, teamwork, and employee training onjob satisfaction. *Procedia-Social and Behavioral Sciences*, 219, 272-282.
- Hersey, P. & Goldsmith, M. (1980). A Situational approach to performance planning. *Training and Development*, No 34.
- Iverson, R. D., & Zatzick, C. D. (2011), The effects of downsizing on labor productivity: The value of showing consideration for employees' morale and welfare in high-performance work systems. *Human Resource Management*, 50(1), 29-44.
- Jafari, A., & MEMARZADE, T. G. (2017). Identification of Effective Factors on Employee Productivity in A Military Health Organization. *Journal of Military Medicine*, 19(3), 234-244.

- Kudyba, S. (2003). Knowledge management: The art of enhancing productivity and innovation with the human resource in your organization. Published in DM Review.
- Mirkamali, S. M., & Ashob, A. (2016). The relationship of spiritual intelligence with the productivity of employees of the cultural- Artistic organization of Tehran Municipality. *Journal of Islamic Management*, 4, 223-244.
- Murray, A., Smith, N., & Millership, A. (2002). Managing Performance Managing People (translation). Jakarta: PT Bhuana Popular Science, p. 7.
- Nardi, B., Whittaker, S, Schwarz, H. (2012). Its not what You know: work in the Information Age, First Monday, May. <http://www.firstmonday.org>
- Omidi N, Askary, H (2016). Prioritizing Effective Factors on police force manpower productivity using multi-purpose decisions, Quarterly Manpower Development and support, eleventh year, No. 39, spring, 104-85
- Paradi, J., & Haiyan Z. H. U. (2016), A survey on bank branch efficiency and performance research with data envelopment analysis. *Omega magazine*, 41(1), 61–79.
- Rosiek, A., Rosiek-Kryszewska, A., Leksowski, Ł., Kornatowski, T., & Leksowski, K. (2016). The employee's productivity in the health care sector in Poland and their impact on the treatment process of patients undergoing elective laparoscopic cholecystectomy. *Patient preference and adherence*, 10, 24-59.
- Shapira-Lishchinsky, O. & Tsemach, S. (2014). Psychological empowerment as a mediator between teachers' perceptions of authentic leadership and their withdrawal and citizenship behaviors. *Educational Administration Quarterly*, 50(4), 675-712.
- Shojaei, S. S., & Manteghi Nikzad, G. R. (2017). Identifying factors affecting manpower productivity, journal of manpower management researches at Imam Hossein University, 8(2), 161-181.
- Tabachnick, B. G., & Fidell, L. S. (2001). Using multivariate statistics. 4th Edition, Allyn And Bacon, Boston
- Taghizadeh, H. (2016). Model of empowerment activities aimed at promoting productivity of employees in the small and medium industries. *Productivity management*, tenth year, 39, 171-190.



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EFFECTIVENESS OF GROWTH STIMULANTS IN THE CULTIVATION OF KOREAN RED PINE SEEDLINGS (*PINUS DENSIFLORA* SIEBOLD ET ZUCC.) IN THE PRIMORSKY KRAI CONDITIONS

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ABSTRACT

The influence of root-feeding stimulants Crezacin, Ribav-Extra, Zircon, Ecopin, Epin-Extra on the growth of Korean red pine seedlings (*Pinus densiflora* Siebold et Zucc.) at growing planting material is studied. Higher growth activity was observed in seedlings fed with growth stimulants Crezacin, Ribav-Extra and Ecopin at solution concentrations of 1ml/5l and 1ml/10l. It was revealed that these stimulants increase the growth of seedlings in height, neck diameter and root lobe length, and biomass. In the second year of seedlings growth, the laying of buds of side shoots was noted. Biennial seedlings, when using these stimulants in terms of growth, meet the requirements of the current OST 56-98-93. They can be used for planting on the forest area and transplanting into the school nursery department, for further cultivation of seedlings.

Disciplinary: Biology (Plant Sciences/Botany).

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1. INTRODUCTION

Primorsky Krai is one of the largest Far Eastern regions of the Russian Federation (Petrovsky, 2004). According to the latest accounting of the forest fund, the total area of forests of the region is 10295.2 thousand hectares. 5341.5 thousand hectares (51.7 %) of this area is occupied by coniferous trees. There are many valuable species of trees, shrubs, and lianas, which are not found anywhere else on the territory of the Russian Federation. In the forest fund representatives of the family "Pine-Pinaceae Lindl." grow everywhere, which is represented by four genera: pine (*Pinus* L.), fir (*Abies* Mill.), spruce (*Picea* A. Dietr.) and larch (*Larix* Mill.).

In the southern districts of the region (Khasansky, Shkotovsky, and Vladivostok), there is natural growth of Korean red pine (*Pinus densiflora* Siebold et Zucc.), occupying a small area – about 4.0

thousand hectares (Koryakin, 2010; Urusov et al., 2004; Urusov et al., 2007).

Korean red pine is an endangered species of the Russian Far East (Urusov et al., 2004; Urusov et al., 2007). It is listed in the Red books of Primorsky Krai and the Russian Federation (Golovanov et al., 1988; Red book of Primorsky Krai: Plants, 2008).

It occurs in separate preserved sporadic areas located on hard-to-reach massifs. The natural habitat of Korean red pine is mountain forests. In the conditions of mountain relief, vulnerable and difficult-to-restore ecological systems, this tree species is one of the best forest-reclamation species for fixing ravines, slopes, sands, protective and roadside strips. It is used in landscaping. However, seed years in the pine forests of the region are repeated in three to four years (Urusov et al., 2004; Urusov et al., 2007; Usenko, 1969). During such periods of storage, seeds reduce germination energy and germination. The use of growth stimulants (regulators), which proved themselves positively in agriculture, can improve the sowing quality of seeds and ensure the restoration of this valuable tree species. Many studies conducted in different forest conditions confirm their prospects. Laboratory and soil germination of seeds are increased. Seedlings grow vigorously. Their safety is high (Galdina & Shevchenko, 2012; Kirienko & Goncharova, 2016; Nikitenko et al., 2005; Ostroshenko & Ostroshenko, 2010; Ostroshenko et al., 2014; Ostroshenko et al., 2015; Ostroshenko, 2014; Pentelkin, 2001; Pentelkina, 2002; Pentelkina & Ostroshenko, 2005).

This work is devoted to the study of the effectiveness of growth stimulants (regulators) of natural (Ribav-Extra, Zircon, Ecopin) and synthetic (Crezacin, Epin-Extra) origin in the growth of Korean red pine seedlings. These growth stimulants have proven themselves positively in agriculture. The research was initiated on the possibility of their application in forestry, particularly in forest restoration [1, 3, 9-11]. (Galdina & Shevchenko, 2012; Kirienko & Goncharova, 2016; Ostroshenko et al., 2014; Ostroshenko et al., 2015; Ostroshenko, 2014).

Crezacin –synthetic adaptogen and immunostimulant triethanolammonium salt of orthocresolacetic acid, $C_{15}H_{25}NO_6$ is characterized by a wide range of biological activity. The drug is easily soluble in water and alcohol, insoluble in ether.

Ribav-Extra is a product of the vital activity of mycorrhizal fungi isolated from ginseng roots by biotechnology and contains a unique natural complex (amino acids, phytohormones, vitamins), which in negligible doses activates all processes of vital activity of plants. Active ingredient of Ribav-Extra: 0.00125 g / l L-alanine + 0.00196 g / l L-glutamic acid.

Growth stimulant Zircon is produced on the basis of purple coneflower and contains esters based on hydroxycinnamic acids dissolved in alcohol, namely, caffeic acid and its derivatives: chicory and chlorogenic acids, which perform the function of the active principle in this preparation and determine its profound effect on plant cell metabolism, participation in the regulation of hormonal status and enzymatic profile (Malevannaya & Bykhovskaya, 2001).

Biological preparation Ecopin is the growth stimulant of natural origin. It consists of 6.2 g/kg of poly-beta-hydroxybutyric acid + terpenic acids + set of nutrients and is a concentrated product of biosynthesis of beneficial soil bacteria + starting set of nutrients. It is a universal biostimulant of plant growth and development, which has an anti-stress effect. The basis of this biological preparation contains a concentrated product of biosynthesis of beneficial soil bacteria and a starting set of nutrients.

Growth stimulator Epin-Extra - a synthetic analog of a natural plant hormone. The active substance of the drug is epibrassinolid, belongs to the class of brassinosteroids, natural plant

hormones. The mechanism of its action is to activate the plants' own phytohormones. It is epibrassinolide that causes the activation of biological processes in plants, literally saving them from diseases, old age and at the time of stress.

In general, the preparations used for the experiments are low-toxic, do not have a mutagenic effect, they are recommended for pre-sowing, root and foliar feeding of plants. These growth stimulants increase sprouting and germination of seeds, increase yields. They are safe for humans, warm-blooded animals, and beneficial insects, practically not dangerous for fish. They reduce the content of heavy metal salts in plants; increase resistance to frost, drought, excessive waterlogging. They are easily soluble in water, do not accumulate in the soil, do not pollute ground and surface water, not phytotoxic and environmentally friendly. The preparations are included in the "List of pesticides and agrochemicals permitted for use in the territory of the Russian Federation" (RMOA, 2017).

The purpose of this work is to study the effect of root fertilization of one-two-year seedlings of Korean red pine (*Pinus densiflora* Siebold et Zucc.) with growth stimulants Crezacin, Ribav-Extra, Zircon, Ecopin, Epin-Extra on their growth and development. Based on this purpose, the following tasks were solved:

1. Analysis of forest conditions of the object of works;
2. Harvesting of Korean red pine seeds and their sowing in the nursery;
3. Conducting root fertilizing of one-year-old seedlings with solutions of growth stimulators of Crezacin, Ribav-Extra, Zircon, Ecopin, Epin-Extra;
4. Agrotechnical care and the subsequent monitoring of seedlings growth by height, root system, and phytomass in the course of two years;
5. Analysis of the influence of these growth stimulants on the cultivation of planting material.

2. WORKING PROCEDURE

The object of research is the nursery of the MTS-branch of the Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS. Seeds of a Korean red pine were collected in the woodland adjacent to the territory of the station in autumn, and in spring they are sown in beds of the nursery.

Preparation of the soil consisted of preliminary manual digging of the soil and the arrangement of ridges for seeds sowing. The height of the ridges was 20 cm from the soil surface. The location of the sowing rows in the beds was transverse. The distance between the centers of the sowing lines was 20 cm, between the variants of experiments – 40 cm. The seeds were soaked in KMnO₄ solution before sowing. The depth of sealing was 1.5 cm.

After germination and the beginning of growing season of the seedlings, then in two weeks of the first year of growth and the beginning of the growing season of the second year of growth (in June), root fertilizing of seedlings with fresh solutions of stimulators was carried out: Crezacin, Ribav-Extra, Zircon, Ecopin, and Epin-Extra. Feeding was carried out in the evening, in dry weather, in the absence of a forecast for rain. Solution concentrations: 1 ml / 5l and 1 ml/10l of water. Control – seedlings did not have root feeding with growth stimulants.

Within two years, the seedlings were carried out regular agrotechnical care, consisting of

weeding and loosening the soil between the sowing lines: in the first year of growth of seedlings – twice, in the second year – once.

The seedlings were regularly watered. Their growth and condition were watched. At the end of the growing season of seedlings, from each variant of the experiment, by random sampling (every fifth seedling), 25 pieces of plants were selected (to ensure a small sample during statistical processing), in which the height of the above-ground part was measured. Average values and model specimens were calculated.

At the end of the growing season, three model seedlings of medium height were dug from each variant of the experiment. The roots of the plants were washed from the substrate, then wiped with a cotton cloth and dried in a shaded room. The length of the root lobe was measured with a ruler in the seedlings selected for the experiments. The diameter of the root neck was measured with a caliper to an accuracy of 0.1 mm. Seedlings were divided into the root system and the aboveground part (trunk, pine needles), dried, weighed on the scales of VLKT-500 to an accuracy of 0.01 g and these growth indicators were determined in the air-dry state.

The materials of the field experiments were statistically processed in the application program Microsoft Excel 2007. The results were compared with the variants of the experiment and with the control. The materiality of differences with control was calculated by Student's t-test (Doev, 2001).

Table 1: The impact of root-feeding stimulants on the growth of one-year Korean red pine seedlings (*Pinus densiflora* Siebold et Zucc.)

№	Growth stimulant / Solution concentration, ml/l	The average value of the height, $M \pm m$, cm	Materiality of differences	Diameter of the root neck, mm	Length of the lobe root, cm
1	2	3	4	5	6
1.	Control	$7,8 \pm 0,2$	-	2,5	6,9
2.	Crezacin				
	1×5	$9,1 \pm 0,2$	$4,6 \geq 3$	2,9	8,1
	Percentage to the control	+16,7		+16,0	+17,4
	1×10	$10,1 \pm 0,1$	$10,5 \geq 3$	3,0	8,6
	Percentage to the control	+29,5		+20,0	+24,6
3.	Ribav-Extra				
	1×5	$10,8 \pm 0,3$	$8,3 \geq 3$	3,2	7,4
	Percentage to the control	+38,5		+28,0	+7,2
	1×10	$11,4 \pm 0,2$	$12,9 \geq 3$	3,3	9,1
	Percentage to the control	+46,2		+32,0	+31,9
4.	Zircon				
	1×5	$8,2 \pm 0,1$	$1,8 \leq 3$	2,7	7,1
	Percentage to the control	+5,1		+8,0	+2,9
	1×10	$8,4 \pm 0,1$	$2,7 \leq 3$	2,9	7,2
	Percentage to the control	+7,7		+16,0	+4,3
	Ecopin				
	1×5	$9,7 \pm 0,2$	$6,8 \geq 3$	3,0	8,3
	Percentage to the control	+24,4		+20,0	+20,3
	1×10	$12,3 \pm 0,4$	$10,0 \geq 3$	3,4	8,6
	Percentage to the control	+57,7		+36,0	+24,6
5.	Epin-Extra				
	1×5	$8,8 \pm 0,2$	$3,6 \geq 3$	2,8	7,4
	Percentage to the control	+12,8		+12,0	+7,2
	1×10	$8,3 \pm 0,3$	$1,4 \leq 3$	2,6	7,3
	Percentage to the control	+6,4		+4,0	+5,8

3. RESULTS

The analysis of the data of meteorological observations carried out at the object of research

shows that the weather conditions during the experiments were within the average long-term.

The positive effect of root fertilizing with stimulants on the growth of experienced seedlings of Korean red pine was noted in the first year of growth. There was an increase in the root system. Thus, when feeding with the stimulant Crezacin, the average values for the length of the root lobe exceeded the control by 17.4-24.6 %, Ribav-Extra by 7.2-31.9 %, Ecopin by 20.3-24.6 %. Stimulants Zircon and Epin-Extra were less effective, exceeding the control by 2.9-4.3 % and 5.8-7.2 %. Accordingly, by the diameter of the root neck, they exceeded the control by 4.0-36.0 %, height 5.1-57.7 %. When using drugs of CrezaCin, Ribav-Extra and Ecopin differences from control were significant (Table 1).

These growth stimulants showed high efficiency in the second year of growth of seedlings. Drugs Crezacin, Ribav-Extra, and Ecopin had a positive effect on the increase in the length of the root lobe, exceeding the control, depending on the concentration of the solution by 21.1-27.5 %, 27.5-29.6 % and 2.8-21.1%. Stimulants Zircon and Epin-Extra had a less positive value. The excess to control was 10.6-13.4% and 4.2-6.3%. By the diameter of the neck root, the excess to the control was in the range of 2.6 to 18.4 %.

All tested stimulants had a positive impact on the growth of seedlings in height, exceeding the control by 15.1-44.3 %. Differences with control were significant (Table 2).

Table 2: The impact of root-feeding stimulants on the growth of two-year-old Korean red pine seedlings (*Pinus densiflora* Siebold et Zucc.)

№	Growth stimulant / Solution concentration, ml/l	The average value of the height, M±m, cm	Materiality of differences	Diameter of the root neck, mm	Length of the lobe root, cm
1	2	3	4	5	6
1.	Control	18,5 ± 0,4	-	3,8	14,2
2.	Crezacin				
	1×5	24,4 ± 0,6	8,2 ≥ 3	4,0	17,2
	Percentage to the control	+31,9		+5,3	+21,1
	1×10	25,1 ± 0,7	8,1 ≥ 3	4,3	18,1
	Percentage to the control	+35,7		+13,2	+27,5
3.	Ribav-Extra				
	1×5	26,7 ± 0,7	10,1 ≥ 3	4,5	18,4
	Percentage to the control	+44,3		+18,4	+29,6
	1×10	25,9 ± 0,7	9,1 ≥ 3	4,2	18,1
	Percentage to the control	+40,0		+10,5	+27,5
4.	Zircon				
	1×5	22,4 ± 0,6	5,4 ≥ 3	4,1	15,7
	Percentage to the control	+21,1		+7,9	+10,6
	1×10	23,9 ± 0,4	9,5 ≥ 3	4,3	16,1
	Percentage to the control	+29,2		+13,2	+13,4
	Ecopin				
	1×5	21,8 ± 0,5	5,2 ≥ 3	4,0	14,6
	Percentage to the control	+17,8		+5,3	+2,8
	1×10	24,6 ± 0,6	8,5 ≥ 3	4,2	17,2
	Percentage to the control	+33,0		+10,5	+21,1
5.	Epin-Extra				
	1×5	22,6 ± 0,5	6,4 ≥ 3	4,1	15,1
	Percentage to the control	+22,2		+7,9	+6,3
	1×10	21,3 ± 0,3	5,6 ≥ 3	3,9	14,8
	Percentage to the control	+15,1		+2,6	+4,2

The growth of seedling mass in the dry state was also more actively influenced by the stimulants Crezacin, Ribav-Extra and Ecopin, exceeding the percentage of control, depending on the

concentration of the solution, respectively: by 128.3-176.4 %, 157.5%, and 140.9-151.2 %. Stimulants Zircon and Epin-Extra were less effective (excess to control – 95.3-116.5 % and, respectively: 23.6-48.8 %) (Table 3).

Table 3: The influence of growth stimulants on the formation of the biomass of two-year-old Korean red pine seedlings (*Pinus densiflora* Siebold et Zucc.)

No	Stimulant	The dry weight of seedling in air-dry condition, g					
		trunk	shoots of the 1st order	pine needles	total aboveground part	root system	total weight
1	2	3	4	5	6	7	8
Solution concentration 1ml / 5 l							
1.	Control	0,37	0,01	0,47	0,85	0,42	1,27
1.	Epin-Extra	0,69	0,02	0,61	1,32	0,57	1,89
	Percentage to control	+86,5	+100,0	+29,8	+55,3	+35,7	+48,8
2.	Zircon	0,71	0,02	0,68	1,41	1,07	2,48
	Percentage to control	+91,9	+100,0	+44,7	+65,9	+154,8	+95,3
3.	Crezacin	0,82	0,03	0,79	1,64	1,26	2,90
	Percentage to control	+121,6	+200,0	+68,1	+92,9	+200,0	+128,3
4.	Ribav-Extra	0,94	0,03	0,89	1,86	1,41	3,27
	Percentage to control	+154,1	+200,0	+89,4	+118,8	+235,7	+157,5
5.	Ecopin	0,88	0,02	0,82	1,72	1,34	3,06
	Percentage to control	+137,8	+100,0	+74,5	+102,4	+219,0	+140,9
Solution concentration 1ml / 10 l							
1.	Epin-Extra	0,54	-	0,57	1,11	0,46	1,57
	Percentage to control	+45,9	-	+21,3	+30,6	+9,5	+23,6
2.	Zircon	0,88	0,02	0,71	1,61	1,14	2,75
	Percentage to control	+137,8	+100,0	+51,1	+89,4	+171,4	+116,5
3.	Crezacin	1,34	0,01	0,84	2,19	1,32	3,51
	Percentage to control	+262,2	-	+78,7	+157,6	+214,3	+176,4
4.	Ribav-Extra	1,23	0,01	0,74	1,98	1,29	3,27
	Percentage to control	+232,4	-	+57,4	+132,9	+207,1	+157,5
5.	Ecopin	0,92	0,01	0,87	1,80	1,39	3,19
	Percentage to control	+148,6	-	+85,1	+111,8	+231,0	+151,2

4. CONCLUSION

The experiments showed that in the cultivation of Korean red pine seedlings in the nursery stimulants Crezacin, Ribav-Extra, and Ecopin had a more positive effect.

Root feeding with growth stimulants carried out in the first year retains its positive effect in the second year of seedlings growing in the nursery.

These stimulators increase the growth of seedlings by biometric parameters: height, the diameter of the neck and length of the root lobe, biomass. In the second year of growth in seedlings laying of side shoots buds was marked.

Biennial seedlings in terms of growth meet the requirements of the current OST 56-98-93. They can be used for planting on the forest area and transplanting into the school department of the nursery, for further cultivation of seedlings.

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

6. REFERENCES

- Doev, S. K. (2001). Mathematical methods in forestry: textbook. *Ussuriysk: PSAA*, 124 p.
- Galdina, T. E., & Shevchenko, K. V. (2012). Assessment of the influence of biostimulators on the condition and quality of seedlings of European spruce (*Picea abies*) [Electronic resource]. *IV International Student Electron. Scient. Conf. "Student scientific forum"*. Access mode: <https://www.rae.ru/forum2012/13/> 559.
- Golovanov, V. D., Fertikov, V. I., Takhtadjian, A. L., Sokolov, V. E., Skarlato, O. A., Zabrodin, V. A., ... & Geltman, D. V. (1988). Red Book of the RSFSR: Plants.
- Kirienko, M. A., & Goncharova, I. A. (2016). The influence of growth stimulants at different concentrations on ground seed germination and survival of seedlings of the main forest forming species of central Siberia. *Sibirskij Lesnoj Zhurnal/Siberian Journal of Forest Science*, (1), 39-45.
- Koryakin, V. N. (Ed). (2010). Handbook for accounting of forest resources of the Far East. responsible compiler and scientific editor. *Khabarovsk: publishing house of FERIF*, 527 p.
- Malevannaya, N. N., & Bykhovskaya, N. V. (2001). Zircon – a new phytopreparation for agriculture, obtained on the basis of unconventional plant raw materials. Chemical and computer modeling. *Butler's reports*, 5, 7.
- Nikitenko, E. A., Gul, L. P., & Korol, L. A. (2005). Study of growth stimulants in the cultivation of planting material of Far Eastern tree species. *Problems of forest protection and multipurpose forest management in the Far East*, 38, 171-175.
- Ostroshenko, V. V., & Ostroshenko, L. Yu. (2010). Influence of stimulants on growth of Korean pine seedlings. *Forestry*, 1, 47-48.
- Ostroshenko, V. V., Ostroshenko, L. Yu., & Ostroshenko, V. Yu. (2015). The use of growth stimulant "Crezacin" in the cultivation of seedlings of the genus "Fir" (*Abies*). *Vestnik of KSAU*, 5, 184-189.
- Ostroshenko, V. V., Poleshchuk, V. A., & Ostroshenko, L. Yu. (2014). Effect of root feeding with stimulant "Epin" on the growth of two-year seedlings of the genus "*Abies* Mill." Theoretical and applied issues of education and science: collection of scientific papers on the materials of the International scientific-practical conference on March 31, 2014: in 13 parts. Part 8. *Tambov: LLC "Consulting company Yukom"*, 120–124.
- Ostroshenko, V. Yu. (2014). The effectiveness of root fertilization with the stimulant "Zircon" in the cultivation of two-year seedlings of Khingan fir (*Abies Nephrolepis* (Trautv.) Maxim. and Manchurian fir (*A. holophylla* Maxim). Problems of sustainable forest management in Siberia and the Far East: materials of All-Russian Conf. with international participation. *Khabarovsk: publishing house of FERIF*, 311-314.
- Pentelkin, S. K. (2001). Application of Agata-25K in forest management. *Forestry*, 2, 41-43.

- Pentelkina, N. V. (2002). Environmentally friendly technologies based on the use of growth stimulants. *Ecology, science, education, upbringing*, 3, 69-71.
- Pentelkina, N. V., & Ostroshenko, L. Yu. (2005). Cultivation of seedlings of coniferous breeds in the North and the Far East with the use of growth stimulants. Actual problems of forestry complex: collection of scientific works of BSITA. *Bryansk*, 10, 125-129.
- Petropavlovsky, B. S. (2004). Forests of Primorsky Krai (Ecological and geographical analysis). *Vladivostok: Dalnauka*, 317 p.
- RMOA. (2017). List of pesticides and agrochemicals approved for use in the Russian Federation. Russian Ministry of Agriculture M., 811 p.
- Red book of Primorsky Krai: Plants*. (2008). Rare and endangered species of plants and fungi. Vladivostok: Orange, 688 p.
- Urusov, V. M., Lobanova, I. I., & Varchenko, L. I. (2004). Coniferous trees and shrubs of the Russian Far East: geography and ecology. *Vladivostok: Dalnauka*, 111 p.
- Urusov, V. M., Lobanova, I. I., & Varchenko, L. I. (2007). Conifers of the Russian Far East – valuable objects of study, protection, breeding, and use. *Vladivostok: Dalnauka*, 440 p.
- Usenko, N. V. (1969). Trees, shrubs, and lianas of the Far East. *Far East Forestry Research Institute, Khabarovsk*.



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MODERN TECHNOLOGIES AND APPROACHES TO THE TRIANGULATION ALGORITHMS

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ARTICLE INFO	ABSTRACT
<p>Article history: Received 20 May 2019 Received in revised form 30 September 2019 Accepted 15 October 2019 Available online 26 November 2019</p> <p>Keywords: Delaunay method; modeling, Triangulation network; Delaunay triangulation; Triangulation method.</p>	<p>Features of organizing the automation systems for engineering calculations are considered. Program realization for the creation of triangular networks, in particular, the generator of networks based on a Delaunay method of creating triangulation is analyzed. Methods of creation of volume networks are also considered. Conformal networks with many-sided cells are presented. Triangulation methods, their essence, merits and demerits, algorithms of creating Delaunay triangulation are described.</p> <p>Disciplinary: Computer Graphics.</p> <p>© 2020 INT TRANS J ENG MANAG SCI TECH.</p>

1. INTRODUCTION

At a solution to modern scientific and engineering tasks, mathematical modeling is widely applied (Bayneva, 2019). There are ready systems of automation of engineering calculations (CAE – Computer-aided engineering) for the analysis and modeling of physical processes on a computer. As a rule, it is the big closed commercial project which is developed for decades groups in several hundred specialists. The majority of the modern CAE complexes consist of a set of libraries for the graphic interface, visualization, creation of estimated networks, sampling of differential equations and a solution of systems of the linear and nonlinear equations.

From the CAE system, users' points of view provide the convenient graphic interface for a task of parameters and statements of the problem, carrying out calculations, display and the analysis of results. The algorithms and methods used for a solution of a specific objective often are hidden from the user.

Important criteria when choosing specific libraries from the point of view of the developer are reliability, simplicity, and cost or a possibility of free use.

2. METHODS OF CREATING TRIANGULATION NETWORK

The methods of creation of networks, such as method of displays, method of the advanced front, methods of sweeping (sweeping) and paving (paving) of area, methods existing today on the basis of octal trees (octree), are applicable or for rather narrow class of areas, or demand manual intervention in process of creation of a network.

There are two main methods of creation of a triangular network on the plane: a method of the advanced front and a method of creating triangulation Delaunay. Both methods can be used for the creation of a conformal triangular network in the set polygon at the set of tops without the addition of new tops.

There is a set of program realization for the creation of triangular networks. Let's note one of the most known reliable generators of triangular networks, the generator of networks Triangle developed by J.R. Shevchuk (1996). This generator of networks is based on a method of creating triangulation Delaunay and allows building conformal triangulations Delaunay, a triangulation Delaunay with restrictions, and triangular networks with high quality. The border of the area is set discretely; there is no opportunity to completely control the desirable size of elements in the area. The generator can use arithmetics with any accuracy for an exception of errors of rounding at calculations, for example, at the calculation of the sign of the determinant.

Usually, the process of creation of a tetrahedral network is divided into two stages:

- 1) creation of a superficial triangulation on area border;
- 2) creation of a tetrahedral network in the area.

In different tasks, the geometrical forms of models are had different complexity. For example, in the case of modeling of physical processes in a homogeneous environment, it is possible to use the area of a simple form in the form of a sphere or a cube.

In engineering, tasks are widely applied by a CAD to the creation of geometrical models of products. Also, the application of 3D scanning for receiving computer models of a real-life object is not excluded. The universal approach does not exist: in different tasks this or that way of a task of the geometry of the model is convenient.

At the creation of a volume tetrahedral network important property of a method is the possibility of preservation of the set network trace on the border. Unlike two-dimensional triangular networks, in a three-dimensional case, there are such many-sided areas for which it is impossible to construct a conformal tetrahedral network with the set trace on the border without the addition of new tops.

At the creation of tetrahedral networks, the methods based on the same ideas as in a two-dimensional case can be used. The classical method of creation of a tetramerization Delaunay builds a network for a convex cover of points and does not guarantee the preservation of the border of the area. Several methods for preservation of borders are offered: local modifications of a network, crushing of a network, and creation of a tetramerization Delaunay with restrictions (CDT – Constrained Delaunay triangulations) (Borouchaki et al, 1995). The algorithm of the advanced front, on the other hand, has no problems with the preservation of the set border as it and begins with it. However, this algorithm can face such a configuration of the front which he is not able to advance. In literature also the hybrid methods based on a combination of the ideas of methods of the advanced front and a tetramerization Delaunay meet (Yang et al, 2005).

In work the combination of two methods is used (Baynev & Fedosin, 2018a; Baynev & Fedosin, 2018b; Baynev & Fedosin, 2019a; Baynev & Fedosin, 2019b). The main method – a method of the advanced front, with its help is under construction for the most part of a network. As an additional method, the simplified version of the method offered by Borouchaki et al. (1995) is applied.

In 3D modeling different types of settlement networks are used: tetrahedral, hexahedral, prismatic (Figure 1), type networks an octal tree (Figure 2); application of hybrid networks with different types of cells is possible. As a rule, all similar types of networks get to a class of conformal networks with many-sided cells.

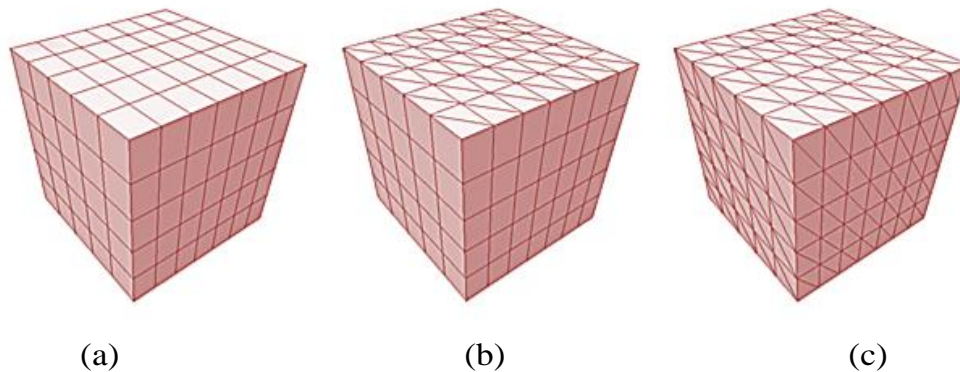


Figure 1: Examples of networks
(a) hexahedron, (b) triangular prismatic, (c) tetrahedral

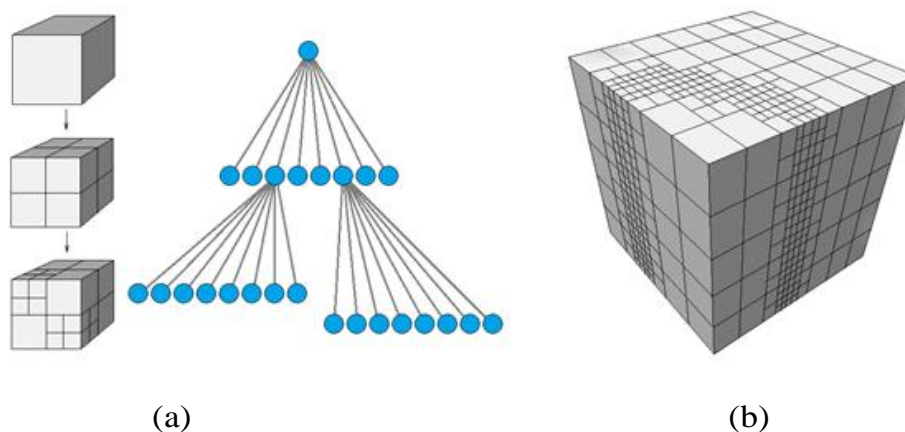


Figure 2: Type network octal tree: (a) construction process; (b) appearance.

3. RESULT AND DISCUSSION

The main numerical algorithms of a solution of applied tasks include an important element – splitting area (surface) in which any processes, on very small standard cells (curvilinear triangles, quadrangles, tetrahedrons, prisms, parallelepipeds, etc.) are investigated. The set of such cells is called a differential network, and their tops – network nodes. Cells of a network and their nodes are a basis on which there is a replacement of the mathematical models describing the studied processes by the system of the algebraic

equations which numerical solution gives an approximate value of necessary characteristics of the studied phenomena. The diverse requirements imposed on differential networks (small deformation of cells, coherence with borders of physical geometry and with features of physical quantities), due process of their creation by a complex mathematical problem.

The process of splitting a surface of objects into polygons is called a tessellation. It is necessary to make at first programmatically a tessellation of source objects, and then to transfer the received polygonal areas for further processing. In practice approximation of a surface by triangular elements (triangles) – a triangulation, therefore, the triangulable network turns out is most often made. Wide use of triangles is explained by the following reasons: the triangle is the simplest polygon which tops unambiguously set an edge; the computing complexity of algorithms of splitting into triangles is significantly less than when using other polygons; implementation of procedures of rendering is simplest for the area limited to a triangle; for a triangle tree, it is easy to define the next the neighbor, having with it the general edges; any surface can be approximated with a necessary accuracy a network of triangles; accuracy of approximation is defined by quantity of triangles and way of their choice.

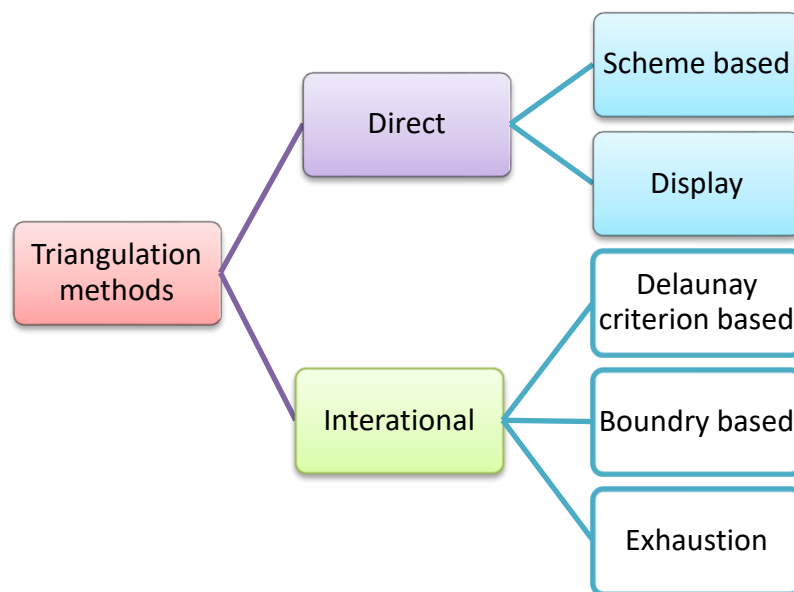


Figure 3: Classification of methods by the principle of construction.

Various methods of triangulation, by the principle of construction which can be broken into two classes, are for practical purposes used: direct and iterative (Figure 3). On scope of application it is possible to select two schemes of a triangulation (Figure 3): two-dimensional when the flat polygon becomes covered by a set of triangles (Figure 4(a)); three-dimensional which can use as approximation elements as flat triangles (Figure 4(b)), and tetrahedrons (Figure 4(c)). In the first case, the surface of the model becomes covered by a set of four triangles connected and not blocked among them. In the second case, the internal volume of a three-dimensional body breaks into a set of 8 tetrahedrons which are not blocked among them.

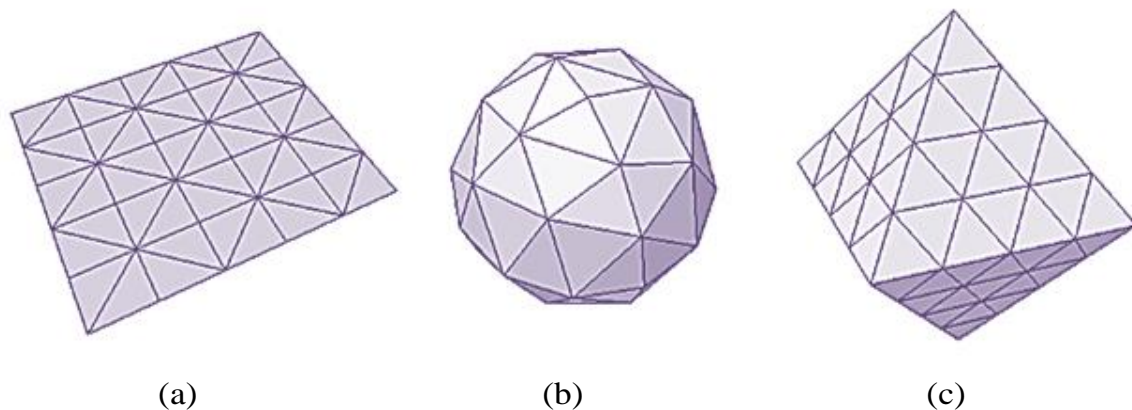


Figure 4: Schemes of a triangulation: (a) 2D triangulation triangles, (b) 3D triangulation triangles, (c) 3D triangulation tetrahedrons.

4. CONCLUSION

Considering algorithms of triangulation are an integral part practically of all 3D software products - schedules works on their improvement and the creation of new algorithms is intensively conducted. It is caused by the instability of a number of known algorithms and the unsatisfactory time of their work on real data sets.

5. AVAILABILITY OF DATA AND MATERIAL

Information used and generated from this work is available by contacting the corresponding author.

6. REFERENCES

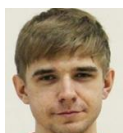
- Baynev, V. V., & Fedosin, S. A. (2018a). Simulation and study of optical systems based on LEDs. *Acta Technica*, 63, 897–902.
- Baynev, V. V., Fedosin, S. A. (2018b). Triangulation networks and hierarchical structures of the models in calculation of LED modules. *International Journal of Engineering and Technology (UAE)*, 7(2), 5-8.
- Baynev, V., & Fedosin, S. (2019a). Implementation and Optimization of Ray Tracing Algorithm in an Optical System. *Journal of Advanced Research in Dynamical and Control Systems*, 11(02), 489-493.
- Baynev, V., & Fedosin, S. (2019b). Surface Presentation Methods in Geometric Models of Light Devices. *Journal of Advanced Research in Dynamical and Control Systems*, 11(02), 460-464.
- Bayneva, I. I. (2019). Features OD Free-Form Optics Design and Manufacture in Lighting Industry. *Journal of Advanced Research in Dynamical and Control Systems*, 11(02), 465-467.

Borouchaki, H., Hecht, F., Saltel, E., & George, P. L. (1995). Reasonably efficient Delaunay based

mesh generator in 3 dimensions. In *Proceedings 4th International Meshing Roundtable* (pp. 3-14).

Shewchuk, J. R. (1996, May). Triangle: Engineering a 2D quality mesh generator and Delaunay triangulator. In *Workshop on Applied Computational Geometry* (pp. 203-222). Springer, Berlin, Heidelberg.

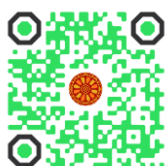
Yang, Y. J., Yong, J. H., & Sun, J. G. (2005). An algorithm for tetrahedral mesh generation based on conforming constrained Delaunay tetrahedralization. *Computers & Graphics*, 29(4), 606-615.



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BEHAVIORAL SIMULATION OF INDUCTION MOTOR TEMPERATURE DISTRIBUTION

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ABSTRACT

The paper justifies the need to monitor and control the thermal state of the induction motor as a whole and its windings, as the most heat-loaded elements. A review of modern methods of measuring and determining the temperature of windings (including rotating) is carried out. It showed trends in the use of non-contact methods for determining temperature using mathematical models based on the finite element method and relevant thermal equivalent circuits. To determine the temperature distribution, an equivalent thermal model of an induction motor, consisting of 53 nodes, 31 of which are heat generating was developed. To determine the losses, a T-shaped equivalent circuit for replacing motor windings was used, taking into account losses in steel, non-linearity of the magnetization curve and the effect of current displacement in the rotor winding. The simulation results in steady and transient modes are presented.

Disciplinary: Electrical Engineering (Motor Engineering).

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1. INTRODUCTION

The widespread use of induction machines in industry and transport is explained by a number of circumstances (Krishnan, 2001; Novotny & Lipo, 1996; Kosmodamianskii et al., 2012):

- the mass of a squirrel-cage induction motor is 1.5-2 times less than the mass of a DC motor of the same power;
- the torque of inertia of the rotor of a short-circuited traction induction motor is two times greater than that of a DC motor;
- the cost of a squirrel-cage induction motor is about 2-3 times less than the cost of a DC motor.

In recent years, significant efforts have been directed towards the development of methods for diagnosing damage and malfunctions of induction machines, as well as the creation of methods for their protection. The most important part of any protection is the availability of thermal protection,

which is necessary to eliminate thermal overloads, and, therefore, extend the traction motor life. Thermal overloads that cause motor damage lead to much more intense insulation damage. In addition, they can lead to failure of the key elements of the machine: insulation of the stator windings, rotor rods, stator core, and rotor, etc.

In Motor Reliability Working Group (1985), an investigation of the damage causes and the analysis of components that fail during the induction motor operation is given. The main results of this work are summarized in Table 1.

Table 1: Damages during the induction motor operation.

Causes of damage	%	Damaged unit	%	On average
Constant overloads	4,2	Stator housing insulation	23	Damage caused by electrical reasons 33,3 %
Insulation aging	26,4	Winding insulation	4	
		Wiring clamp	3	
		Stator core	1	
		Stems of the "squirrel" cage	5	
<i>Total</i>	<i>30,6</i>	<i>Total</i>	<i>36</i>	
Increased vibration	15,5	Plain bearing	29	Damage caused by Mechanical reasons 31,35 %
Deteriorated lubrication	15,2	Rotor shaft	2	
		Rotor core	1	
<i>Total</i>	<i>30,7</i>	<i>Total</i>	<i>32</i>	
High ambient temperature	3	Bearing seats	6	Damage caused by operating conditions and other reasons 35,35 %
Humidity changes	5,8	Oil (grease) leak	3	
Voltage imbalance	2,1	Frame	1	
Chemically hazardous environment	4,2	Cooling fins	1	
Poor cooling	3,9			
Other reasons	19,7	Other units	21	
<i>Total</i>	<i>38,7</i>	<i>Total</i>	<i>32</i>	

Despite different evaluation criteria, both studies show a very close percentage of damage caused by electrical and mechanical reasons.

Analyzing the data shown in Table 1, a larger number of damage is caused by the heating of certain parts of the electric machine.

Overheating of the insulation of the motor windings is usually caused by the following reasons:

- dynamic overloads during transients (starting, braking, reverse, switching to another speed);
- high mechanical loads, and, as a result, high currents in the windings (thermal overloads);
- an asymmetric source of electricity;
- high ambient temperature;
- poor cooling conditions.

It was shown in (Kosmodamianskii et al., 2011), that the frontal part of the most loaded stator phase experiences the greatest thermal loads with asymmetries in the supply voltage. According to the studies conducted for the most unfavorable phase shift value, with asymmetry coefficient values of up to 2% and direct sequence voltage drops of up to 5%, thermal overloads can reach 10 ... 17%, resulting in a significant reduction in the period of trouble-free operation.

Kosmodamianskii et al. (2011) studied the effects of temperature on the static mechanical characteristics of an electric drive with an ED-900 induction motor, see results in Figure 1.

A general view of the mechanical characteristics is shown in Figure 1, a (designations: M - motor torque, w - rotor speed). An analysis of the graphs (Figure 1) allows us to conclude that an increase in

the temperature of the windings θ of the induction motor entails a decrease in the critical torque M_m (Figure 1, b) and an increase in the absolute critical slip sk (Figure 1(c)), which causes a significant decrease in the stiffness of the mechanical characteristics of β (Figure 1(d)).

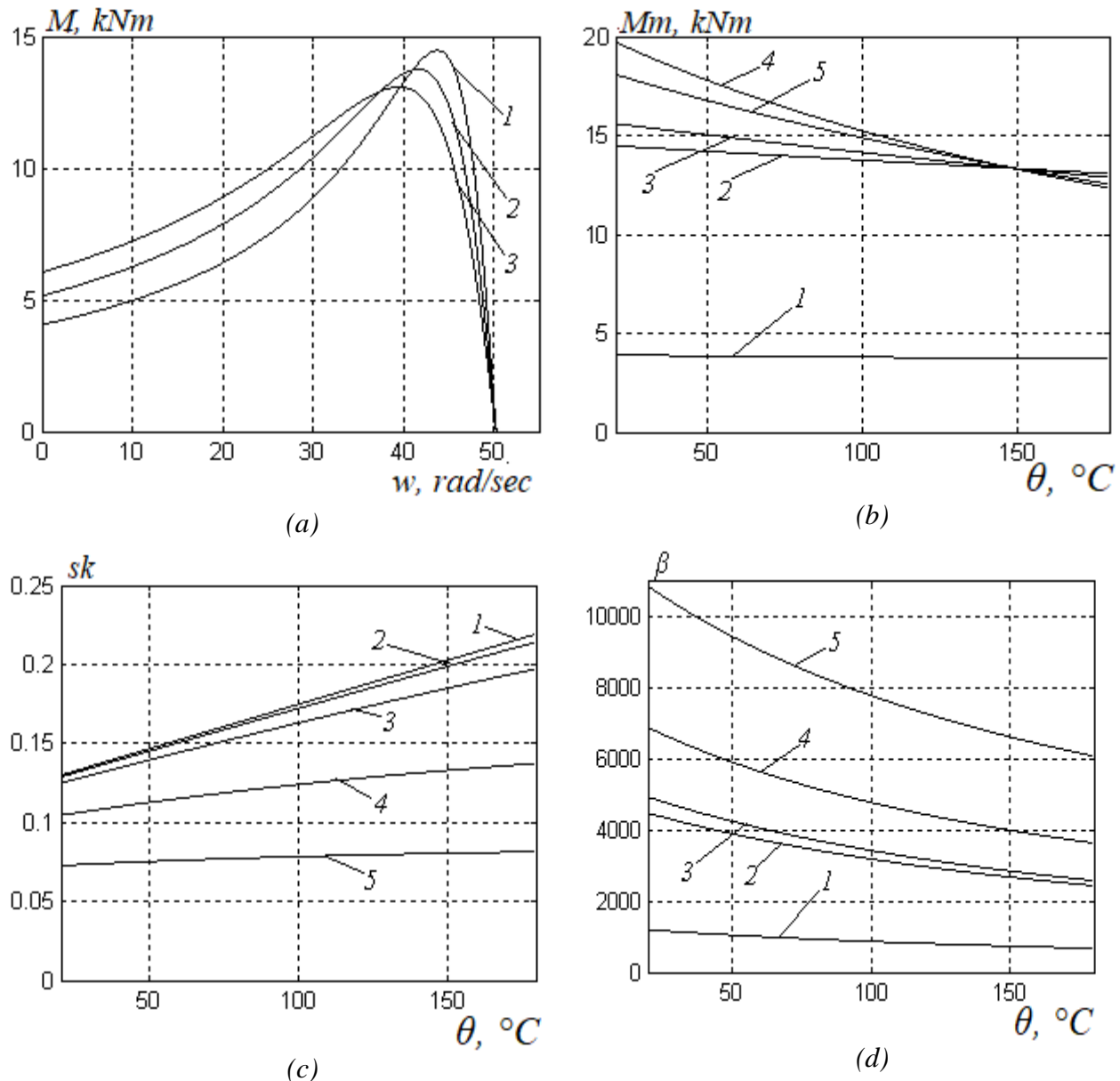


Figure 1: Mechanical characteristics (a) at nominal parameters of the supply voltage (1– $\theta = 20^\circ\text{C}$, 2– $\theta = 100^\circ\text{C}$, 3– $\theta = 180^\circ\text{C}$), dependences of the critical torque (b), absolute critical slip (c) and stiffness (d) on the temperature of the windings (1– $f_1 = 48\text{ Hz}$, 2– $f_1 = 24\text{ Hz}$, 3– $f_1 = 12\text{ Hz}$, 4– $f_1 = 4.8\text{ Hz}$, 5– $f_1 = 2.4\text{ Hz}$).

This is explained by an increase in temperature with an increase in the active resistance of the stator and rotor windings, which leads to a decrease in the absolute critical slip, since the temperature dependence of the inductive resistance of the windings is weak, and the stator supply voltage does not affect the critical slip value at all. A change in the absolute critical slip under the influence of temperature is more pronounced in the zone of high frequencies of the stator current (42% at a stator current frequency of $f_1 = 48\text{ Hz}$). The smallest slip sensitivity to temperature is manifested at low frequencies (13% at a stator current frequency of $f_1 = 2.4\text{ Hz}$) since in this mode it is determined mainly by the ratio of the active resistance of the stator and rotor windings.

The critical torque decreases significantly with increasing temperature, which is the most

pronounced in the low-frequency zone (at a nominal frequency $f_1 = 24 \text{ Hz}$, the decrease in torque is 10.5%, at the stator current frequency of 2.4 Hz - 55%). When operating at high frequencies (in the second zone), the influence of the temperature of the windings is weakly expressed, since the operation in this mode is determined mainly by the short circuit inductive resistance.

A similar effect of temperature on the torque and slip leads to a decrease in stiffness with increasing temperature, the more the lower the stator current frequency is (71% at a stator current frequency of $f_1 = 2.4 \text{ Hz}$, 5% at a stator current frequency of $f_1 = 48 \text{ Hz}$)

In (Lim & Nam, 2004), the economical coefficient is taken as a criterion for evaluating the electric drive efficiency:

$$\varepsilon(f_2) = \frac{I_1^2}{M} \rightarrow \min \quad (1)$$

where I_1 – stator winding current;

M – torque developed by the electric drive.

Figure 2 shows the dependences of the coefficient $\varepsilon(f_2)$ for the DAT-305 motor.

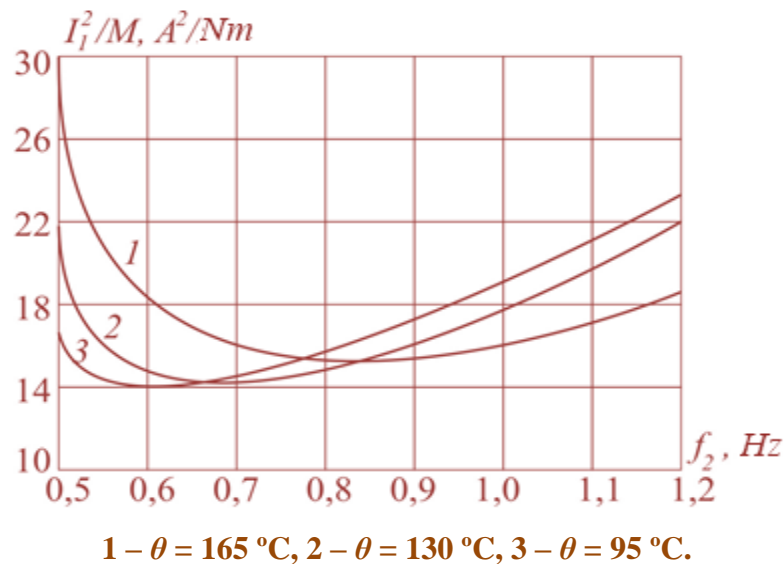


Figure 2. The dependence of the DAT-305 motor efficiency coefficient on the rotor current frequency f_2 at various values of the temperature of the windings θ

Figure 2 shows that when the temperature of the traction motor windings increases, the rational value of the rotor winding current, according to the condition $\varepsilon(f_2) \rightarrow \min$, shifts to the large slip zone: at $\theta = 95 \text{ }^{\circ}\text{C}$, $f_{2 \text{ opt}} = 0,63 \text{ Hz}$, at $\theta = 165 \text{ }^{\circ}\text{C}$, $f_{2 \text{ opt}} = 0,87 \text{ Hz}$. The stator current and voltage amplitudes themselves, delivering $\varepsilon(f_2) \rightarrow \min$, vary insignificantly. The deviation of the rotor current frequency from the rational leads to a sharp increase in the stator winding current and an increase in the economic coefficient.

Despite the rational control of the motor running at all temperatures with the lowest possible stator current values, with an increase in the temperature of the windings, its efficiency coefficient decreases because the value of the efficiency coefficient $\varepsilon(f_2)$ increases: at the temperature of the windings $\theta = 0 \text{ }^{\circ}\text{C}$, $\varepsilon(f_2) = 10,5 \text{ A}^2/\text{Nm}$; at a temperature of the windings $\theta = 180 \text{ }^{\circ}\text{C}$, $\varepsilon(f_2) = 14,4 \text{ A}^2/\text{Nm}$.

An increase in losses with increasing temperature will inevitably lead to a decrease in traction motor efficiency: with an increase in temperature in the range of 0 ... 180°C, efficiency decreases from 89 to 77% (Kosmodamianskiy et al., 2015). At the same time, the torque on the shaft of the traction motor decreases.

Thus, in modern control systems, it is necessary to take into account the influence of the temperature of the windings on the processes occurring in the power and control systems (Kosmodamianskiy et al., 2015; Kosmodamianskii et al., 2015).

2. METHODS USED TO STUDY THE INDUCTION MOTOR THERMAL STATE

In the process of studying the thermal processes of motors, the following temperature control methods can be used: the resistance method, the method of built-in temperature sensors, and the thermometer method.

The resistance method involves the use of the dependence of the resistance of the motor windings on temperature. In this case, the average temperature of the motor winding is measured, both with the voltage removed and with the voltage applied. The main disadvantage of this method is the significant hardware costs in the case of motors operated under voltage.

A prerequisite for using the second method of built-in temperature sensors when determining the temperature of electric motor assemblies is the presence of built-in temperature sensors such as thermocouples, resistance thermometers, infrared temperature sensors, etc., for example, in the array of the motor stator winding. The implementation of this technical solution seems possible only in the manufacture of the motor. At the same time, only a small part of the motors operated today have such sensors in their design, which is explained by a number of economic and technical reasons related to the cost, difficulty of installing sensors and their operation.

Using the third method involves registering the motor surface temperature. The lack of information about the temperature of its internal nodes is the main disadvantage of this temperature control method.

Currently, taking into account the development of the microprocessor and digital systems, a method for controlling the induction motor temperature based on the data of a mathematical model of thermal processes calculated with the help of known (measured) electrical parameters as well as motor design parameters is widely used.

The choice of the thermal model should be based on a comprehensive analysis of the induction motor (IM) operating environment. In modern conditions, there is a need to develop thermal models to analyze the operation of induction electric drives with frequency control.

The mathematical modeling of thermal processes occurring in an electric motor has been the subject of many scientific works (Staton, 2001; Mahdavi et al., 2013; Kylander, 1995; Pugachev & Kosmodamianskii, 2017; Mellor et al., 1991; Staton & Cavagnino, 2008; Champenois et al., 1994; Huai et al., 2003; Trigeol et al., 2006; Mezani et al., 2005; Kosmodamianskii & Pugachev, 2018; Briz et al., 2008). Moreover, the methods discussed in them are divided into two types: using the finite element method (FEM) and using the equivalent thermal circuits (ETC).

The application of the FEM method involves a significant amount of calculations using special software systems, such as ANSYS, which makes it possible to simulate thermal fields, as well as the availability of obtaining detailed information about the geometric dimensions of the motor structural components. Staton (2001) considered the features of convective exchange between air flows in the motor cooling channels. The issues related to natural and forced cooling are analyzed. The relevant criteria and design relationships for determining the Nusselt number are given. Moreover, the calculations for stationary thermal processes were performed. In (Mahdavi et al., 2013), using FEM,

modeling of non-stationary thermal processes occurring in the motor stator was made. According to the results of experimental studies, it was concluded that the mathematical model has high accuracy in the simulation of stationary thermal processes, and in dynamics, an error can reach 10°C.

The second type of methodology, based on ETC, is widely used in the development and study of motors. It allows determining the average temperature values of individual motor nodes.

There is a fairly large number of scientific works devoted to the study of the induction motor thermal state based on ETC (Kylander, 1995; Pugachev & Kosmodamianskii, 2017; Mellor et al., 1991). In all of them, schemes with varying degrees of detail, with a different number of nodes and heat-loaded nodes of the induction motor are used. However, in most works there are no calculation formulas and calculation methods for determining the thermal resistances of these equivalent circuits are not given. Along with this, a correct determination of the thermal model resistances is the key to its adequate operation in steady and transient modes.

To numerically solve the problem of inhomogeneous heat conduction in a body with distributed heat sources, the finite difference method is used, which, with a grid step commensurate with the linear dimensions of the IM elementary nodes, is converted to the method of equivalent thermal circuits (ETC) for solving three-dimensional problems of heat conduction and heat transfer.

When using the ETC method to calculate temperature fields in an electric machine, a heat system with continuously distributed parameters is replaced by an equivalent system of homogeneous bodies (nodes), between which conductive connections, determined by the corresponding heat exchange processes are established, which allows such systems of equations to be solved by standard numerical methods.

The basis for such a transition is the ability to consider the distribution of the thermal field in the element as a result of the interaction of several one-dimensional heat fluxes. The error that arises, in this case, depends on the linear dimensions of the elementary nodes.

When calculating the temperature fields of electric machines for research purposes, the number of nodes the machine is divided into can be selected by almost anyone that guarantees a given calculation accuracy. For circuit nodes with insignificant heat reduced capacity in comparison with other nodes, namely, for the nodes of the air flows in the machine channels, on the basis of the theory of heat transfer in thermally coupled bodies, the differential equations describing the thermal state of the nodes are replaced by algebraic equations.

The general form of the equation describing the thermal state of the i -th node of the system that is in contact with adjacent n nodes has the form

$$\frac{\partial \theta_i}{\partial t} = P_i - \sum_{n=1}^n \frac{\theta_i - \theta_n}{R_{i,n}}, \quad i = 1 \dots n. \quad (2)$$

$\partial \theta_i$ – a small increment of the temperature of the i -th node, °C for a small-time increment ∂t , c;

P_i – the power loss of the i -th node, W (equal to zero if the node is passive);

θ_i – instant value of the temperature of the i -th node, °C;

θ_n – the instantaneous temperature of the adjacent node, °C (1 ... n);

$R_{i,n}$ – the thermal resistance of an adjacent node (1 ... n) in contact with the i -th node, °C/W;

$\sum_{n=1}^n \frac{\theta_i - \theta_n}{R_{i,n}}$ – the sum of the differences in the instantaneous temperatures of the i -th node with

each contacting adjacent node (1 ... n), assigned respectively to the thermal resistances of these nodes, W .

The ETC method, as it was said above, consists in determining the average temperatures of individual motor nodes. It can be used not only to study the stationary thermal state of the motor but also in the case of unsteady thermal states.

The thermal state of the motor for non-stationary thermal conditions can be described by a complex system of interconnected elements. The processes taking place in these elements can be represented by a system of differential equations in partial derivatives with interconnected boundary conditions.

If we make an assumption (not considering the temperature fields of each individual motor node), then we can use the first-order system of linear differential equations to describe the unsteady heat process. In this case, the number of equations is equal to the number of bodies the motor is divided into. In this case, the number of ETC nodes should equal the number of bodies. The differential heat balance equation is written for each ETC node.

In (Staton & Cavagnino, 2008), an increase in motor average temperature values up to 29% is indicated. Due to the fact that the additional losses in the rotor are about 65% of the total additional losses of the motor, the most significant is their combined influence along with changing cooling conditions. An analysis of the works related to the calculation and experimental studies of the thermal state of frequency control motors under various control laws makes it possible to conclude that the temperature distribution along the length of the rotor array has the form of an asymmetric bell.

Based on a review of literature (Staton, 2001; Mahdavi et al., 2013; Kylander, 1995; Pugachev & Kosmodamianskii, 2017; Mellor et al., 1991; Staton & Cavagnino, 2008; Champenois et al., 1994; Huai et al., 2003; Trigeol et al., 2006; Mezani et al., 2005; Kosmodamianskii & Pugachev, 2018; Briz et al., 2008), the ETC method was adopted as the chosen method for studying the temperature distribution in the induction motor, which enables us to calculate the thermal state of motor components in all modes of its operation with a slight error.

3. EQUIVALENT THERMAL CIRCUIT OF THE INDUCTION MOTOR

The motor has a complex structure, which complicates the task of its thermal modeling. The complexity and at the same time the accuracy of the thermal model will largely depend on the number of nodes considered. Critical temperatures are recorded for various parts of the stator a rotor winding of induction motors. It is important to take this into account when developing an equivalent thermal model and design such motor units with a large number of elements to achieve the most accurate calculation results.

The general view of the IM ETC is schematically shown in Figure 3(a).

From the thermal point of view, the induction motor consists of fifty-three heat-loaded nodes, 31 of which are heat-generating ones (in Figure 3(b) the heat-generating (active) nodes are made with black filling (for example, unit 19), passive units have no filling). The selection of these nodes was made on the basis of a review of studies of the thermal state of induction motors of various designs, purposes, and cooling schemes.

A fragment of the designed ETC corresponding to the sketch is shown in Figure 3(b). ETC is symmetrical about the vertical axis and the right-hand side (is not shown in Figure 3(b)) is similar to

the left-hand side (fragment is shown in Figure 3(b)).

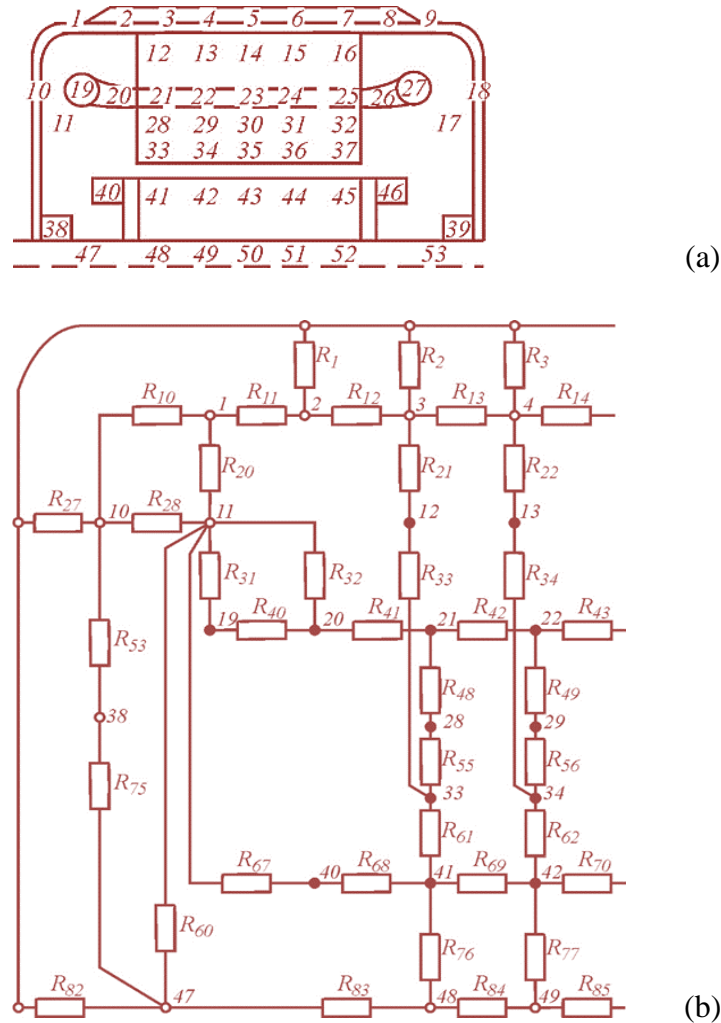


Figure 3. Sketch (a) and a fragment of the equivalent thermal circuit of induction motor: 1–10, 18 denote frame, 11, 17 denote internal air, 12–16 denote stator yoke, 19, 20, 26, 27 denote end parts of stator winding, 21–25 denote slot part of stator winding, 28–32 denote upper part of the stator teeth, 33–37 denote the lower part of stator teeth, 38–39 denote bearings, 40, 46 denote end ring of rotor winding, 41–45 denote bars of rotor winding, 47–53 denote rotor shaft, black nodes denote the source of power losses (active nodes), hollow nodes denote passive units

The power loss in the motor active nodes is determined on the basis of the IM simulation using a T-shaped equivalent circuit of the motor with the rotor parameters brought to the parameters of the stator winding and replacing the motor mechanical load with alternating active resistance (Figure 4) (Lim & Nam, 2004; Kosmodamianskiy et al., 2015).

The main sources of IM losses are copper of the stator and rotor windings (rods and their rings), steel of the stator and rotor cores, as well as mechanical friction losses in the bearings. For the correct determination of losses in an equivalent IM circuit, it is necessary to take into account all-electric and magnetic losses. The greatest difficulty is accounting for steel losses.

The inclusion in the equivalent circuit of resistance parallel to mutual inductance, which is proportional to the losses in steel, is the best option for their modeling (Lim & Nam, 2004). With this approach, the distribution of losses in the rotor windings, stator steel, and stator windings is in the best agreement with the actual picture. Figure 2.13 shows an equivalent circuit of one motor phase for the case described above.

Figure 4 uses the following designations R_c , R_s , R_r - resistance, equivalent to losses in steel,

resistance of the stator and rotor windings (reduced to the stator winding); L_μ , $L_{\sigma s}$, $L_{\sigma r}$ - mutual inductance, dissipation inductance of the stator winding and rotor (reduced to the stator winding); I_s , I_c , I_r , I_μ , U_s - currents and voltage in the corresponding branches of the circuit.

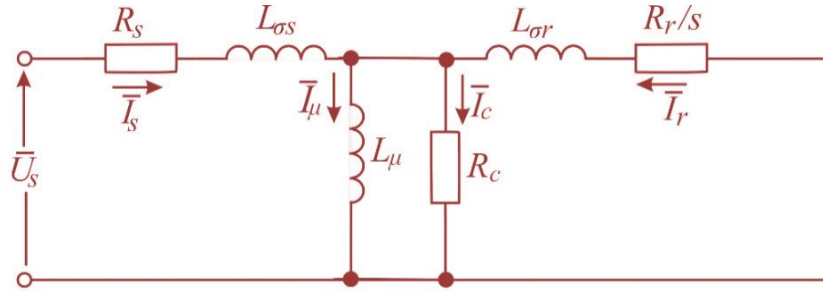


Figure 4: Equivalent circuit of one phase of the induction motor.

In order to consider the influence of eddy currents, it is possible to turn inductance in parallel with the R_c resistor. However, an analysis of the papers showed that the calculation accuracy will change insignificantly if this inductance is neglected (Aissa & Eddine, (2009)).

The consideration of the nonlinearity of steel losses on frequency is determined by the dependence:

$$R_c = \begin{cases} 88.3135 + 5.646f_s + 0.0534f_s^2, & f_s \leq 50\text{Hz}, \\ 1261.3 - 37868/f_s, & f_s > 50\text{Hz} \end{cases}$$

Due to the fact that the effect of current displacement has a significant influence on an induction motor when it operates at lower frequencies, the resistance of the rotor winding must be determined with its consideration to obtain the most complete picture of energy and electromechanical processes. Accordingly, the expressions for determining active and inductive resistance will take the form:

$$R_r = K_R R_{r\pi} + R_{r\pi}, \quad X_r = K_X X_{r\pi} + X_{r\pi},$$

where $R_{r\pi}$ and $X_{r\pi}$ - resistance sections of short-circuit rings between adjacent rotor rods, $R_{r\pi}$ and $X_{r\pi}$ - resistance of the groove part of the rotor winding, K_R and K_X - coefficients that take into account changes in the active and inductive rotor resistances under the effect of current displacement:

$$K_R = \xi \frac{\text{sh}2\xi + \sin 2\xi}{\text{ch}2\xi - \cos 2\xi}, \quad K_X = \frac{3}{2\xi} \cdot \frac{\text{sh}2\xi - \sin 2\xi}{\text{ch}2\xi - \cos 2\xi},$$

where $\xi = 2\pi \cdot 10^{-3} \cdot h \cdot \sqrt{\frac{sf_1 b}{10\rho b_{\pi}}}$ - reduced rod height, b - rod width, h - rod height, b_{π} - groove width, ρ - specific resistance of the rod material.

To study the effect of temperature on the distribution of power losses during the induction motor operation, we use the following temperature dependence of the active resistance of the windings:

$$R = R_{20} [1 + \alpha(T - T_{20})], \quad (3)$$

where R_{20} - active resistance of the induction motor winding at a temperature of $T_{20} = 20^\circ\text{C}$,

α – temperature coefficient of resistance,

T – current temperature of the winding.

In order to analyze the energy processes occurring in the motor, it is necessary to evaluate them according to the following expressions.

Losses in the stator winding of the motor, W

$$\Delta P_s = 3I_s^2 R_s.$$

Losses in the winding (rods) of the motor rotor, W

$$\Delta P_r = 3I_r^2 R_r.$$

Losses in the core of the motor stator, W

$$\Delta P_c = 3I_c^2 R_c.$$

The torque developed on the motor shaft, N·m

$$M = 2M_c \frac{\left(1 + \left(\frac{R_s}{R_r}\right) s_k\right)}{\left(\frac{s}{s_k} + \frac{s_k}{s} + 2s_k \frac{R_s}{R_r}\right)}, \quad (4)$$

where M_c – the critical torque of the motor, N·m;

s – slipping;

s_k – critical slipping.

To study the dependence of loss power on the motor torque, we solve Expression (4) with respect to the motor slip using a computer.

$$s = - \frac{s_k \left(\sqrt{-(R_r + R_s s_k) \cdot (M - M_c) \cdot (MR_r + M_k R_r - MR_s s_k + M_k R_s s_k)} \right)}{MR_r} - \frac{M_k R_r}{MR_r} + \frac{MR_s s_k}{MR_r} - \frac{M_k R_s s_k}{MR_r}, \quad (5)$$

The resulting Expression (5) is substituted into the system of Equation (3) and its roots should be found.

The calculation of the main energy characteristics of an induction motor is performed for the motor in question in the Matlab software package.

AO-63-4 motor parameters: $U_{snom} = 220$ B; $I_{lnom} = 27,4$ A; $2p = 4$; $M_{nom} = 89$ N·m, $P_{nom} = 14$ kW; $n_{nom} = 1460$ rpm; $f_{s,nom} = 50$ Hz; $X_{\sigma s} = 0,73$ Ohm; $X_{\sigma r,nom} = 1,68$ Ohm; $R_s = 0,34$ Ohm; $R_{r,start} = 0,41$ Ohm; $R_{r,nom} = 0,29$ Ohm; $X_{\mu,nom} = 31$ Ohm; $R_c = 504$ Ohm; $X_{\sigma r,start} = 0,73$ Ohm, where $2p$ – the number of poles of the stator winding, P_{nom} – nominal motor power.

4. DIFFERENTIAL EQUATIONS OF THE THERMAL STATE OF THE MOTOR. DETERMINATION OF SPECIFIC HEAT CAPACITIES OF THE MOTOR ELEMENTS

Depending on the mode of operation, unsteady thermal processes (transient thermal processes) occur in all IMs in different volumes. They differ from stationary (steady-state) ones in that the temperature of heating of the elements of the IM structures varies with time, that is, the heating curves contain aperiodic (free) components. Non-stationary thermal conditions can be caused by the

induction motor start, change in supply voltage and frequency, voltage and frequency control, reversal of the motor, and changes in the load on the shaft.

During the development of the motor ETC, the task was to study dynamic thermal processes that can be simulated by introducing the heat capacity of the nodes in Equation (3). As a result, the general form of the differential thermal state equation for the i -th motor node, compiled on the basis of the nodal potentials method written in the Cauchy form takes the form

$$C_i \frac{\partial \theta_i}{\partial t} = P_i - \sum_{n=1}^n \frac{\theta_i - \theta_n}{R_{i,n}}, \quad i = 1 \dots n. \quad (6)$$

The heat capacity of the i -th element of the motor is calculated as follows

$$C_i = \sum_{j=1}^l m_l \cdot c_l, \quad (7)$$

where m_l – element mass, kg,

c_l – specific heat of the material the motor element is made of, J / kg · K. The l index in Expression (7) indicates various materials the motor element is made of.

In most cases, the heat capacity of the motor elements is determined quite simply if the certificate data and geometric dimensions are known. However, the heat capacities of some motor nodes need comment. The stator winding heat capacity consists of heat capacities of copper and insulation. The insulation mass can be calculated based on the coefficient of free space in the stator groove and the area of its isolation. It is also assumed the cross-sectional area of the turns of the frontal part of the stator winding equals the cross-sectional area of the turns in the groove part. Figure 5 shows a fragment of the inclusion of the heat capacities of elements in the previously developed ETC of the motor.

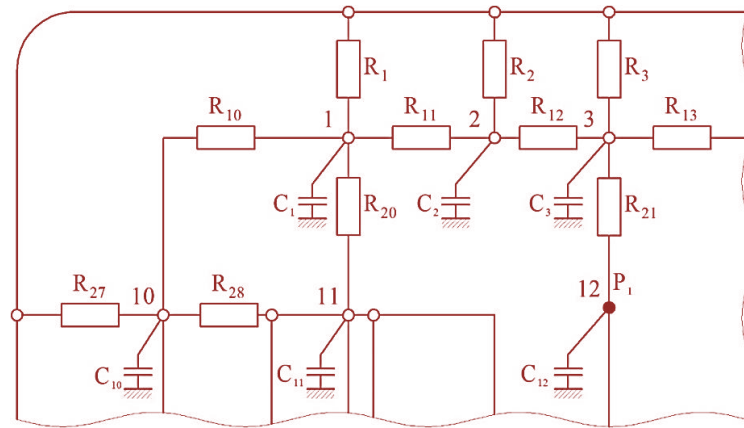


Figure 5: Fragment of a dynamic ETC.

For ETC units in non-stationary modes, we specify the masses used to determine their heat capacities: $m_1 \dots m_9$ are the masses of the elementary parts of the motor block, m_{10} and m_{18} are the masses of the left and right end caps of the motor block, $m_{12} \dots m_{16}$ are the masses of the elementary parts of the core stator, $m_{19} \dots m_{27}$ – masses of elementary segments of the stator winding, $m_{28} \dots m_{37}$ – masses of elementary segments of stator teeth, m_{38} and m_{39} – masses of motor bearings, $m_{40} \dots m_{46}$ – masses of elementary segments of the rotor winding, $m_{47} \dots m_{53}$ – masses of elementary parts of the rotor shaft.

The system of differential equations of thermal state for 53 engine nodes takes the form

according to Expression (6).

5. SIMULATION RESULTS

The developed dynamic ETC of the motor in question was used to simulate thermal processes at various values of the supply current of $0.8 I_{nom}$, $0.9 I_{nom}$ and $1.0 I_{nom}$. The system of differential equations consisting of Equation (6) was solved by the Taylor method.

Figures 6-9 show the heating curves of the motor components for four cross-sections, obtained as a result of modeling in Matlab Simulink, with a supply current of $0.8 I_{nom}$. To study the motor thermal state, the following units were selected: 1 - stator winding, 2 - rotor winding (rods), 3 - core with rotor shaft, 4 - upper part of stator teeth, 5 - the lower part of teeth, 6 - stator core and 7 - motor housing. The time of the transitional heating process is taken to be 12000 s or 200 minutes.

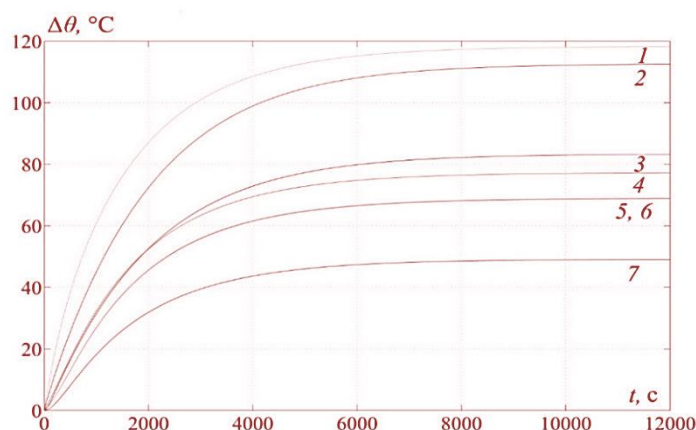


Figure 6: Heating curves of the motor components in a cross-section passing through the frontal part of the stator winding from the cooling air supply side.

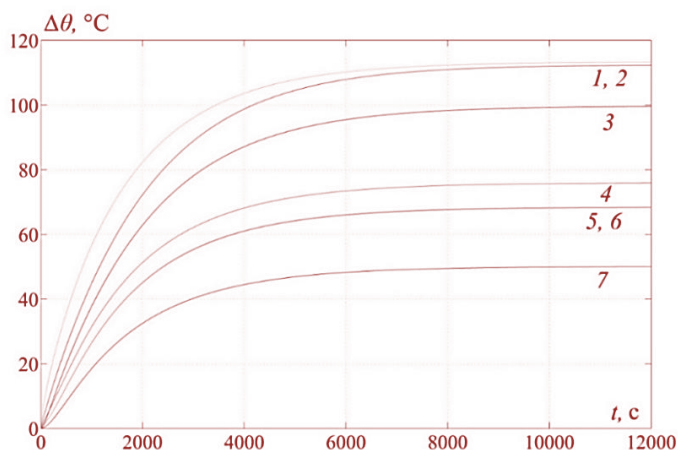


Figure 7: Heating curves of the motor components in the middle cross-section.

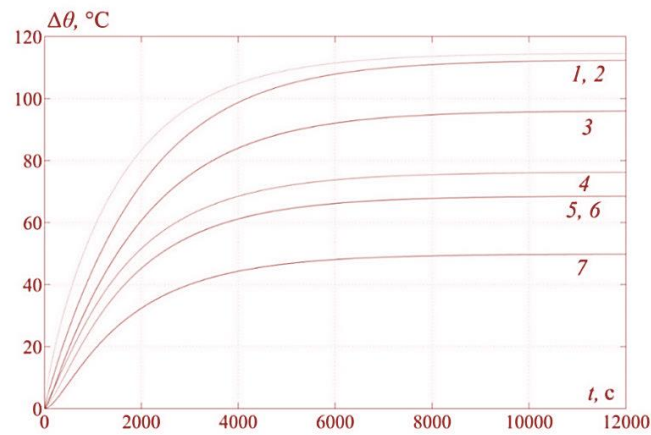


Figure 8: Heating curves of the motor components in the transverse cross-section at a distance of 2/3 of the stator winding from the cooling air supply side

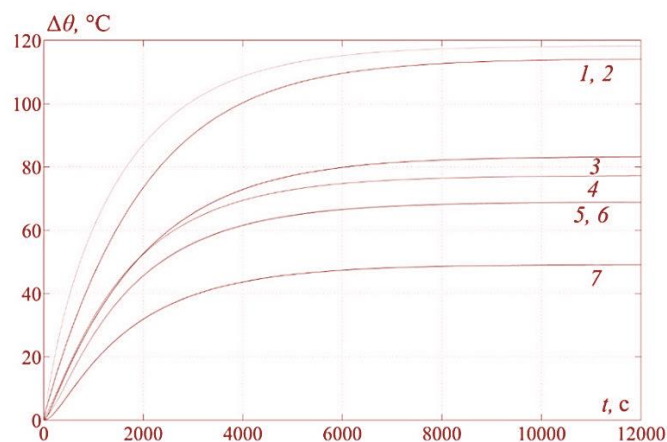


Figure 9: Heating curves of the motor components in the transverse section passing through the frontal part of the stator winding opposite to the cooling air supply side.

The resulting cooling curves of the motor components with a supply of cooling air equal to $G_{air} = 0.95 \text{ m}^3 / \text{s}$ and a stator current TAD equal to $0.8 I_{nom}$ are shown in Figures 10-13. The transitional process of cooling the motor was 9000 s or 150 min.

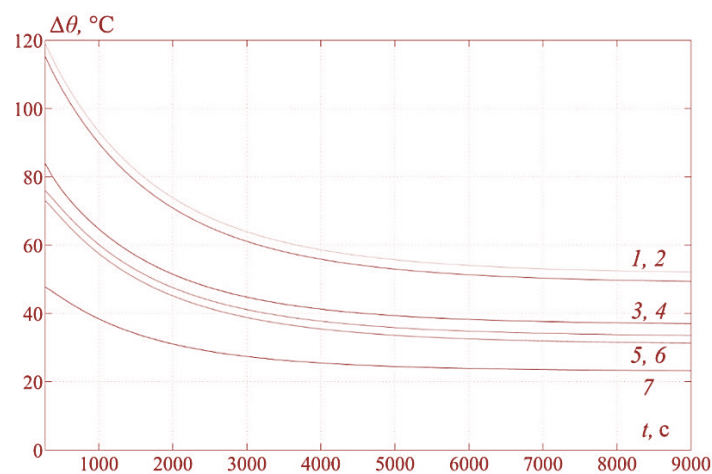


Figure 10: Cooling curves of motor components in a cross-section passing through the frontal part of the stator winding from the cooling air supply side.

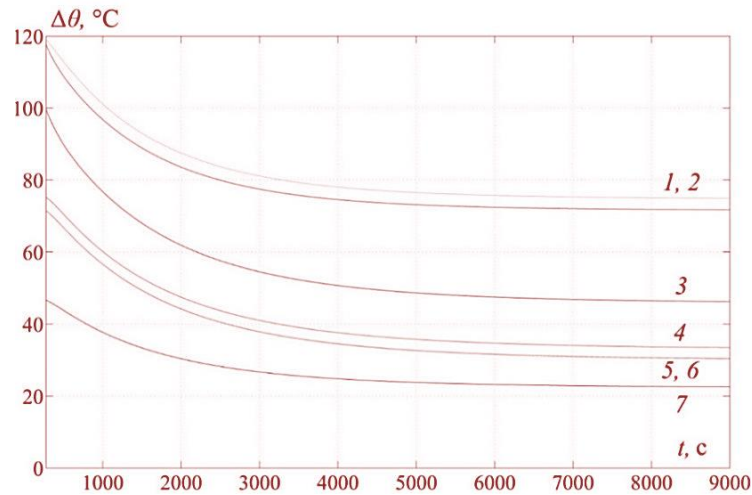


Figure 11. Cooling curves of motor components in the middle cross-section.

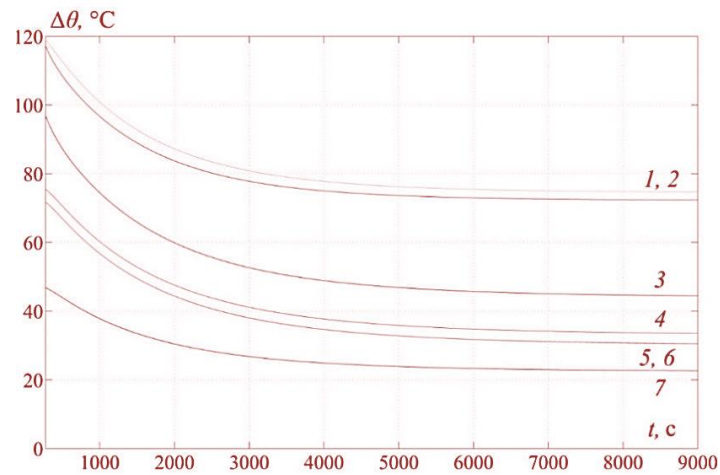


Figure 12: Cooling curves of motor components in the transverse cross-section at a distance of 2/3 of the stator winding on the cooling air supply side.

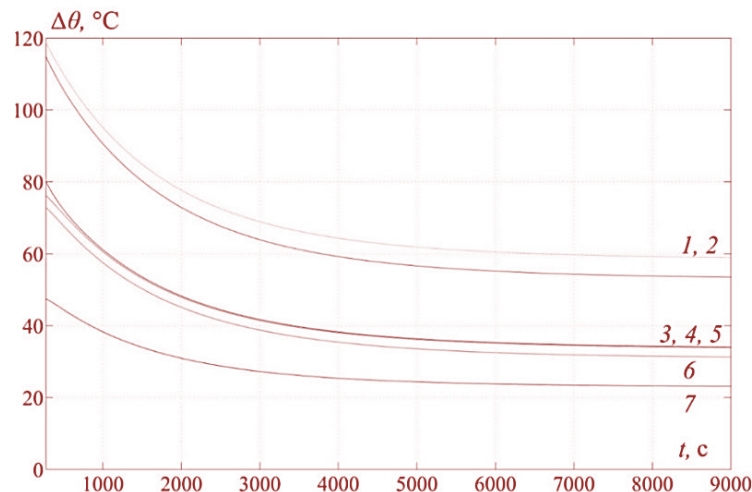


Figure 13: Cooling curves of motor components in the transverse cross-section passing through the frontal part of the stator winding from the opposite side of the cooling air supply.

In the process of studying the thermal state of the motor, the temperature excess distributions along the length of the stator and rotor were considered and are shown in Figures 14 - 16. The curves were plotted at nine and five points respectively for the stator and rotor using the third-order Lagrange interpolation polynomial. The reference point along the abscissa is the point of cooling air entry.

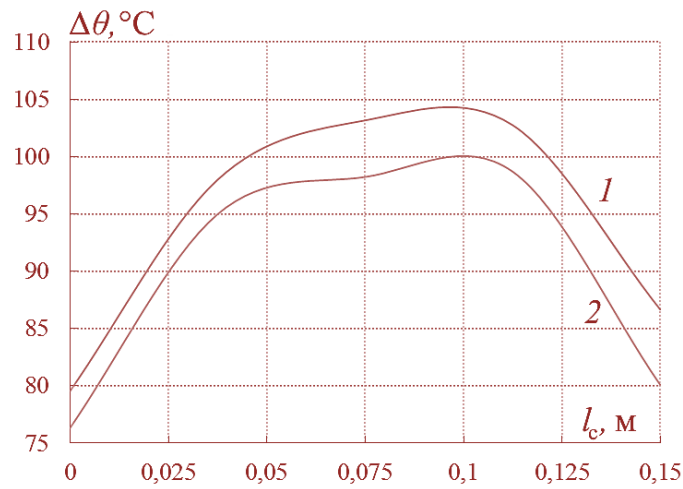


Figure 14: Temperature distribution along the length of the stator I and rotor 2 winding at $I_s = 0.8 I_{nom}$.

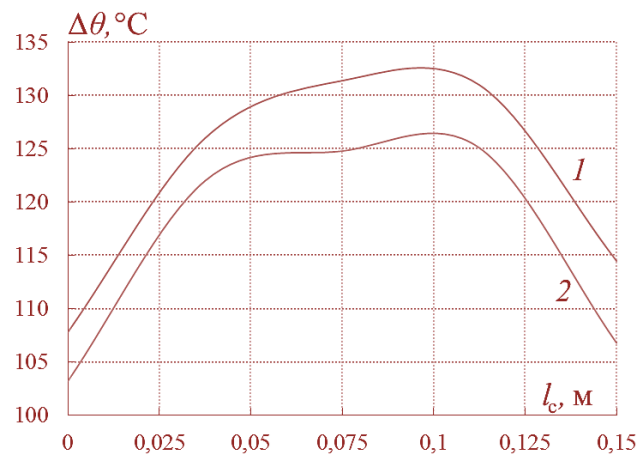


Figure 15: Temperature distribution along the length of the stator I and rotor 2 winding at $I_s = 0.9 I_{nom}$

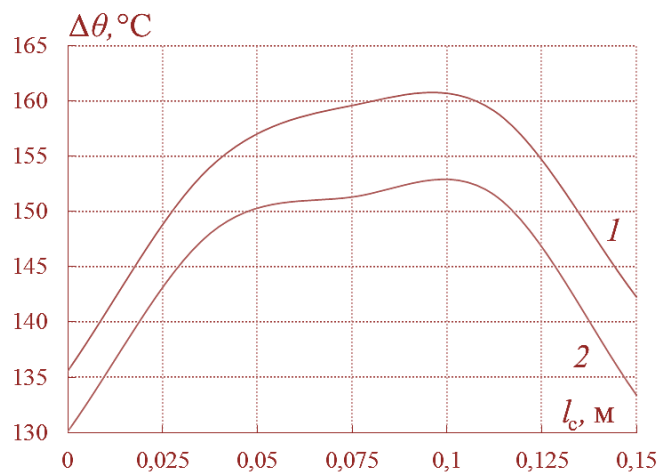


Figure 16: Temperature distribution along the length of the stator I and rotor 2 winding at $I_s = 1.0 I_{nom}$

6. DISCUSSION

The analysis of the results shown in Figures 6-9 allows us to conclude that the most heated motor components in the absence of cooling are the stator and rotor windings in the middle section. The temperature of the stator winding is on average 5°C higher than the temperature of the rotor winding along the entire length of the motor. The least heated motor assembly is the motor housing.

As the results in Figures 10–13 demonstrate, the most heat-loaded motor component when using cooling is the groove part of the stator winding at a distance of 2/3 of its length on the cooling air supply side. The next largest heating motor component is the winding (rods) of the rotor.

According to the results in Figures 14–16, the temperature distribution along the length of the stator and rotor windings is in the form of an asymmetric bell. At the same time, a larger temperature difference between the stator winding and the rotor, which reaches 10°C, corresponds to a larger I_s value of the stator current.

The results obtained confirm that the more intense the induction motor mode of operation, i.e. the greater the stator current and the more intense heat generation, the more different are the temperatures of adjacent parts of the electric machine.

The analysis of the results indicates that the stator winding of the induction motor experiences the greatest overheating. This is because, unlike the rotor, the stator does not have ventilation ducts and blades for forced cooling. Therefore, in the synthesis of cooling systems or automatic temperature control systems, all considerations regarding the IM temperature must be attributed to the stator winding as a temperature-limiting component.

The application of the developed model allows us, in addition to determining local temperatures at individual points of the motor, to find the average temperature values of the stator and rotor windings to correct the value of the current resistance of the windings, which is critical for closed-loop vector control systems and direct torque control.

The use of simulation modeling is fraught with obvious difficulties associated with the fact that the exact determination of the thermal circuit parameters is difficult because it requires too much information, both theoretical and experimental studies of a particular type of motor. In addition, some parameters change directly during operation, depending on the speed and temperature of the cooling air, humidity, etc. All of these factors can introduce errors in temperature determination.

At the same time, the proposed approach has an absolute advantage over the indirect determination of the average temperature by taking into account changes in the stator winding resistance, since in the latter case, satisfactory accuracy is ensured either only in the low-frequency mode of the stator current, at which the voltage drop across the stator active resistance is comparable with the ETC induced by the stator winding, or by introducing an additional component into the voltage supplied to the stator winding (Kosmodamianskii & Pugachev, 2018), which is difficult to implement in electric drives with vector control, where the task for the stator voltage is determined by the settings of the regulators of closed current loops. An additional component is considered by regulators as a disturbance, which, depending on the settings, they seek to minimize or completely eliminate. The resulting calculation accuracy is comparable to the accuracy provided by the ETC use.

Thus, the use of behavioral modeling to assess the temperature distribution over the internal volume of an induction motor and the average temperatures of the stator and rotor windings is a competitive option and its accuracy depends on the completeness and reliability of the initial data on the design, size and materials of the induction motor, and the performance depends on the hardware support of calculations.

7. CONCLUSION

The analysis of the heating and cooling processes of induction motors showed that the steady and unsteady thermal state of an induction motor directly depends on the design features, geometric dimensions, as well as the cooling method used. The accuracy of mathematical calculations is

determined by the correctness of the source data. Therefore, the results of calculations of thermal models for different motors will give different results, and not only in quantitative but also in qualitative terms. Therefore, confirmation of the adequacy of the developed mathematical model of thermal processes in an electric machine based on data obtained in other papers will be incorrect and unreliable. Thus, to predict the induction motor thermal state during its operation, it is necessary to develop its own mathematical model for a specific type of electric motor. Checking the adequacy of the mathematical model should be carried out according to the data obtained during experimental tests on the investigated motor, or its physical model.

In this work, to study the thermal state of the motor, the ETC method is adopted. A mathematical model has been developed for studying steady and transient thermal processes of the induction motor, consisting of fifty-three nodes, thirty-one of which are active sources of heat. As a result of the behavioral modeling of the IM ETC, it was found that the groove part of the stator winding experiences the greatest overheating at a distance of $2/3$ from the cooling air inlet, the next largest heating component is the rotor winding (rods) from the side opposite to the cooling air supply; the difference in temperature between the groove part of the stator winding and the rotor rods can reach $2-10^{\circ}\text{C}$, the transition process for all IM nodes is approximately the same and differs by no more than 5-10%. The reliability of the results is confirmed by the results of the experimental studies.

The application of the developed model allows us to determine both local temperatures in individual motor nodes and average values of the temperature of the motor windings, which is why behavioral modeling based on ETCs can be recommended for use not only in cooling systems (automatic temperature control) but in control systems of electric drives as well.

8. AVAILABILITY OF DATA AND MATERIAL

Information used and generated from this work is available by contacting the corresponding author.

9. ACKNOWLEDGMENT

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10. REFERENCES

- Aissa, K., & Eddine, K. D. (2009). Vector control using series iron loss model of induction motors and power loss minimization. *World Academy of Science, Engineering and Technology*, 52, 142-148.
- Briz, F., Degner, M. W., Guerrero, J. M., & Diez, A. B. (2008). Temperature estimation in inverter-fed machines using high-frequency carrier signal injection. *IEEE Transactions on Industry Applications*, 44(3), 799-808.
- Champenois, G., Roye, D., & Zhu, D. S. (1994). Electrical and thermal performance predictions in inverter-fed squirrel-cage induction motor drives. *Electric machines and power systems*, 22(3), 355-369.
- Huai, Y., Melnik, R. V., & Thogersen, P. B. (2003). Computational analysis of temperature rise phenomena in electric induction motors. *Applied Thermal Engineering*, 23(7), 779-795.
- Kosmodamianskii, A. S., & Pugachev, A. A. (2018). Modeling of Sensorless Determination of the Resistance and Temperature of the Stator and Rotor Windings of an Asynchronous Motor. *Russian Electrical Engineering*, 89(9), 512-517.

- Kosmodamianskii, A. S., Vorob'ev, V. I., & Pugachev, A. A. (2012). Induction motor drives with minimal power losses. *Russian Electrical Engineering*, 83(12), 667-671.
- Kosmodamianskii, A. S., Vorob'ev, V. I., & Pugachev, A. A. (2015). Direct torque control of induction motors fed by a single frequency converter. *Russian Electrical Engineering*, 86(9), 527-533.
- Kosmodamianskii, A. S., Vorobiev, V. I., & Pugachev, A. A. (2011). The temperature effect on the performance of a traction asynchronous motor. *Russian Electrical Engineering*, 82(8), 445.
- Kosmodamianskiy, A. S., Vorobiev, V. I., & Pugachev, A. A. (2015). Automatic temperature regulation system of locomotive traction induction motors with power losses minimization. *JITA-JOURNAL OF INFORMATION TECHNOLOGY AND APPLICATIONS*, 9(1).
- Krishnan, V. (2001). *Electric Motor Drives: modeling, analysis and control*. Virginia Tech, Blacksburg, VA.
- Kylander, G. (1995). *Thermal modelling of small cage induction motors*. Chalmers University of Technology.
- Lim, S., & Nam, K. (2004). Loss-minimising control scheme for induction motors. *IEE Proceedings-Electric Power Applications*, 151(4), 385-397.
- Mahdavi, S., Herold, T., & Hameyer, K. (2013, October). Thermal modeling as a tool to determine the overload capability of electrical machines. In *2013 International Conference on Electrical Machines and Systems (ICEMS)* (pp. 454-458). IEEE.
- Mellor, P. H., Roberts, D., & Turner, D. R. (1991, September). Lumped parameter thermal model for electrical machines of TEFC design. In *IEE Proceedings B (Electric Power Applications)* (Vol. 138, No. 5, pp. 205-218). IET Digital Library.
- Mezani, S., Takorabet, N., & Laporte, B. (2005). A combined electromagnetic and thermal analysis of induction motors. *IEEE transactions on Magnetics*, 41(5), 1572-1575.
- Motor Reliability Working Group. (1985). Report of large motor reliability survey of industrial and commercial installations, Part I. *IEEE Trans. Industrial Applications*, 1(4), 865-872.
- Novotny, D. W., & Lipo, T. A. (1996). *Vector control and dynamics of AC drives* (Vol. 1). Oxford university press.
- Pugachev, A. A., & Kosmodamianskii, A. S. (2017). A simplified equivalent thermal circuit for the substitution of a stator in an induction motor. *Russian Electrical Engineering*, 88(9), 600-604.
- Staton, D. A. (2001, June). Thermal computer aided design-advancing the revolution in compact motors. In *IEMDC 2001. IEEE International Electric Machines and Drives Conference (Cat. No. 01EX485)* (pp. 858-863). IEEE.
- Staton, D. A., & Cavagnino, A. (2008). Convection heat transfer and flow calculations suitable for electric machines thermal models. *IEEE transactions on industrial electronics*, 55(10), 3509-3516.
- Trigeol, J. F., Bertin, Y., & Lagonotte, P. (2006). Thermal modeling of an induction machine through the association of two numerical approaches. *IEEE Transactions on Energy Conversion*, 21(2), 314-323.



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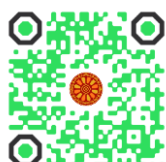
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IMPACTS OF BANKING SYSTEM AND STOCK MARKET ON FIRM PERFORMANCE: EVIDENCE FROM VIETNAM'S REAL ESTATE SECTOR

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ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received 31 July 2019 Received in revised form 15 October 2019 Accepted 04 November 2019 Available online 26 November 2019</p> <p><i>Keywords:</i> Financial development; Domestic credit; Stock market capitalization; Real estate firm; Vietnam's sustainable development.</p>	<p>The paper investigates the impact of the banking system and stock market on the performance of real estate firms in Vietnam. Data are obtained from financial reports of 35 real estate firms and the World Bank database in the 2013-2017 period. By using the Generalized Method of Moment (GMM) in estimating the research model, the author finds first empirical evidence on the influence of the banking system and stock market on firm performance. Specifically, consistent with the earlier studies, the paper reveals that domestic credit to private sector (DCP) exerts a positive impact on firm performance (ROA). Also, it concludes an unprecedented finding that is stock market capitalization (SMC) is negatively correlated to firm performance (ROA). More than that, the results also stress that firm performance is significantly more influenced by developments in the banking system than those in the stock market. Based on these findings, the authorities in Vietnam can develop its banking system, stock market and real estate firms sustainably.</p> <p>Disciplinary: Management Sciences (Finance and Banking), Financial Engineering.</p> <p>©2020 INT TRANS J ENG MANAG SCI TECH.</p>

1. INTRODUCTION

The inextricable link between the banking sector and stock market developments can typically indicate for financial development of each country (Greenwood & Jovanovic, 1990; Bencivenga & Smith, 1991; Pradhan et al., 2014; Bui, 2019b). In particular, the improvements in financial development make good conditions to maintain operation as well as enhance the performance (King & Levine, 1993). It is because financial development helps firms promote the ability to access to capital (Rajan & Zingales, 1998; Levine et al., 2000; Love, 2003; Beck et al., 2006; Bui, 2020a), thereby increasing investment and performance (Levine, 2005; Bui, 2020a; 2020c). The influence

of financial development on firm performance has been concluded in a majority of researchers, namely Guiso et al. (2004), Dehejia et al. (2007), Fafchamps and Schündeln (2013), Lee (2015), O'Toole and Newman (2017), Bui (2020a). Therefore, financial development plays a key role in stimulating firm performance. In other words, corporate performance is likely influenced by the banking sector and the stock market. Accordingly, firms can access capital from the banking system and equity (by issued shares) as well as loans (by issued bonds) from the stock market. However, most of the empirical studies only examine the causality between financial development and firm performance from the perspective of the banking sector, not of the stock market. In fact, access to medium- and long-term capital from the stock market is essential for companies in the context of international integration. Thus, one of their limitations is that they only analyze the link from the perspective of the banking system. Alternatively, the impact of the banking sector and equity market on corporate performance is an interesting and vital research topic with big gaps that need to be filled.

This study aims to give the answer to the question “How do the banking system and stock market influent firms’ performances?” To find the answer, this work investigates the simultaneous effect of the banking sector and the stock market on the performance of real estate firms in Vietnam. The real estate sector is selected for the analysis due to its close association with the stock market. Recently, the developments in the banking system and stock market have increased considerably (Figure 1).

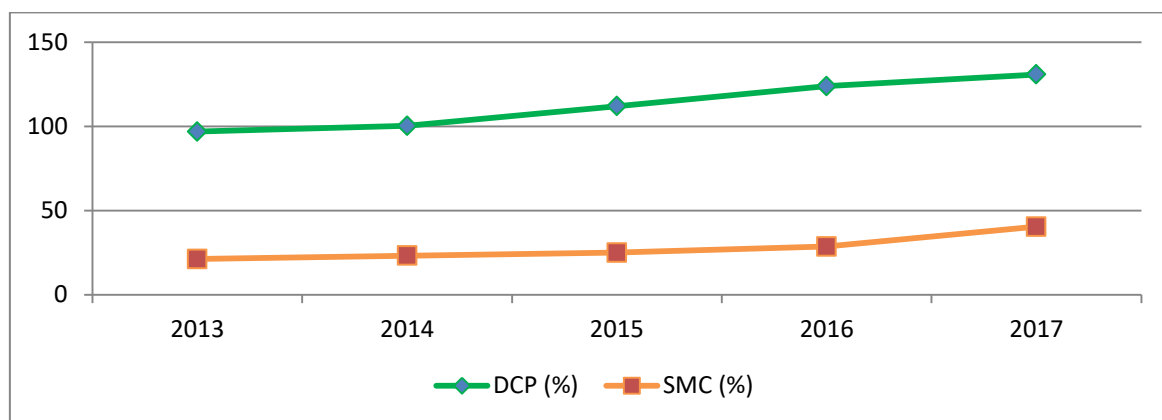


Figure 1: Domestic credit to private sector and stock market capitalization in Vietnam.
Source: Computed by Author.

Nevertheless, Vietnam real estate market has experienced many predicaments in accessing capital from the banking sector and stock market because the banking system seems a bit hesitant in loans to the real estate industry. This is understandable with the fact that the real estate industry is one of the major reasons causing the global financial crisis in 2007. On the other hand, it is limited to access to capital from the Vietnam stock market which is still nascent (Bui, 2019a; Bui, 2020b), and deficient in investing funds in the real estate market. Hence, it is necessary to find empirical evidence on the impact of the banking system and stock market on the performance of real estate companies. This will bring Vietnam’s authorities a fully comprehensive perspective on this nexus and in turn provide a reliable basis in promoting sustainable growths in the banking sector, stock market and real estate firms.

2. LITERATURE REVIEW

Developing the banking system and stock market can be defined as a process in which their quantity, quality, and effectiveness are improved (Pradhan et al., 2014). The banking sector and stock market play an essential role in supplying the capital to the economy. Therefore, the inextricable link between the banking sector and stock market developments can typically represent for financial development of an economy (Greenwood & Jovanovic, 1990; Bencivenga & Smith, 1991; Pradhan et al., 2014; Bui, 2019b). Financial development plays a key role in helping firms operate well (King & Levine, 1993), increase the ability to access to capital (Rajan & Zingales, 1998; Levine et al., 2000; Love, 2003; Beck et al., 2006; Bui, 2020a), and most notably enhance the performance (King & Levine, 1993; Levine, 2005; Bui, 2020a). The linkage between financial development and firm performance has been analyzed in a majority of empirical research. For example, Guiso et al. (2004) stressed that financial development is positively correlated to firm performance in Italy. Dehejia et al. (2007) concluded that financial expansion via the banking system plays a vital part in fostering mechanization in agriculture and growth in manufacturing. Fafchamps and Schündeln (2013) claimed that financial development from the perspective of the banking sector exerts a positive influence on small and medium enterprises in Morocco. By analyzing data in Europe, Lee (2015) confirmed the positive impact of financial development from the perspective of banking on firms' earnings which is clearly observed during the financial crisis. Recently, Chauvet and Jacolin (2017) believed that difficulties in accessing credit are big obstacles to the development process of the private sector. In another research, Fowowe (2017) claimed that firms (in 30 African countries) which are easy to access to credit tend to accelerate more rapidly than those with credit constraints. Moreover, O'Toole and Newman (2017) investigated data in Vietnam and revealed the effects of financial development on access to credit and corporate growth in terms of turnover, investment, employment and productivity.

In general, most of the prior studies have found the positive causality between financial development and firm performance. Nevertheless, most of them measure financial development from the perspective of the banking system. Meanwhile, together with the banking sector, developments in the stock market are indicative of the financial development of an economy.

3. DATA AND METHODOLOGY

3.1 DATA

The panel data has been collected from 35 real estate firms listed on the Ho Chi Minh City Stock Exchange for 2013-2017. This is the period when the Vietnam economy has overcome a recession and its real estate market has gradually recovered, so the access to capital from the banking sector and equity market is really essential. Data on the banking system and stock market are obtained from the database of the World Bank.

3.2 METHODOLOGY

The study examines the impact of the banking system and the stock market on the performance of real estate firms in Vietnam. By this objective, the research model is estimated by employing the Pooled Regression model (Pooled OLS), Fixed effects model (FEM) and Random effects model

(REM). Then, the Generalized Method of Moment (GMM) estimator is adopted to ensure the reliability of the estimated results. The GMM estimator is better at controlling for potential endogeneity and fixing violated regression assumptions (Doytch & Uctum, 2011).

Following earlier studies, the author measures firm performance by return on assets (ROA). Meanwhile, the growth of the banking system is measured by domestic credit to private sector (% of GDP). Domestic credit to private sector (DCP) has been adopted to indicate for the banking system and financial development in almost all of the prior studies. In addition, stock market capitalization is also utilized to be an indicator of stock market development. Stock market capitalization (SMC) is one of the most important financial development indexes of the World Bank. The adoption of the stock market capitalization in the model is expected to reveal unprecedented findings. Besides, following Lee (2015), firm size (logarithm of total assets) is also included as a control variable.

Thus, the estimated model is written in the following equation:

$$ROA_{it} = \beta_0 + \beta_1 DCP_t + \beta_2 SMC_t + \beta_3 SIZE_{it} + \varepsilon_{it} \quad (1)$$

Where:

Dependent variable: Firm performance (ROA).

Independent variables: Domestic credit to private sector (DCP), stock market capitalization (SMC).

Control variable: Firm size (SIZE).

The term ε_{it} is the model regression error term.

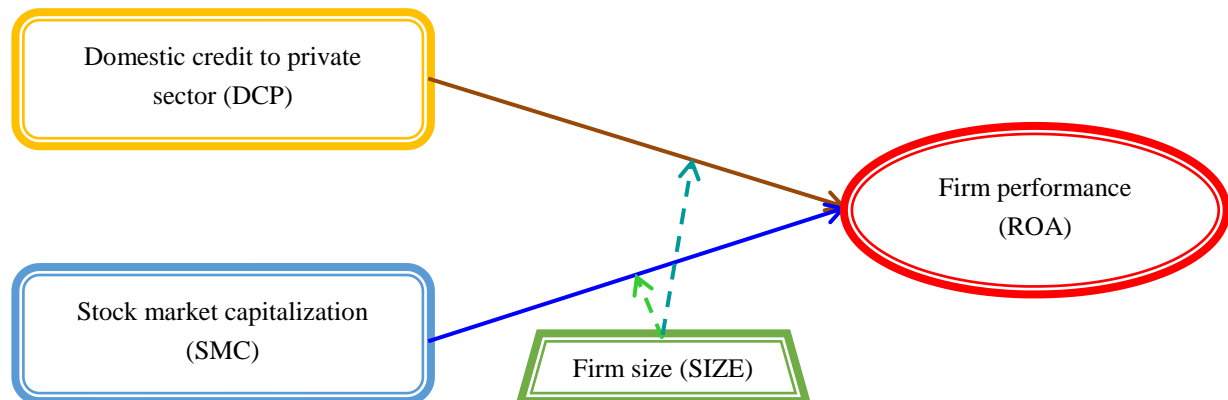


Figure 2: The impact of the banking system and stock market on firm performance.
(Source: Compiled by Author based on theory and prior literature.)

Table 1: Summary of variables

Variable name	Code	How to measure
Dependent variable		
Firm performance	ROA	Net profit / Total assets
Independent variables		
Domestic credit to the private sector	DCP	Domestic credit to private sector (% of GDP)
Stock market capitalization	SMC	Stock market capitalization to GDP (%)
Control variable		
Firm size	SIZE	The logarithm of total assets

Source: Compiled by Author based on theory and prior literature.

4. RESULT

The correlation coefficients between variables in the research model are described in Table 3.

Table 2: Correlation coefficients between variables

	ROA	DCP	SMC	SIZE
ROA	1.000			
DCP	0.492	1.000		
SMC	-0.110	-0.032	1.000	
SIZE	0.273	0.111	0.049	1.000

Source: Computed by Author.

Table 2 shows that the stock market capitalization (SMC) variable negatively correlates with firm performance (ROA). Meanwhile, the remaining variables are positively correlated with firm performance (ROA).

The results of estimating the research model by the methods of the Pooled Regression model (Pooled OLS), Fixed effects model (FEM) and Random effects model (REM) are presented in Table 3.

Table 3: Results of estimating the research models using Pooled OLS, FEM, REM methods.

ROA	Pooled OLS	FEM	REM
Constant	-50.658***	-71.262***	-57.830***
DCP	0.332***	0.315***	0.327***
SMC	-0.077*	-0.046	-0.053
SIZE	0.838***	1.659***	1.107***
R2	30.15%	44.50%	43.95%
Significance level	F(3, 171) = 24.60 Prob > F = 0.000***	F(3, 137) = 36.62 Prob > F = 0.000***	Wald chi2(3) = 109.54 Prob > chi2 = 0.000***
F test	F(34, 137) = 4.19 Prob > F = 0.000***		
Hausman test	chi2(3) = 4.34 Prob>chi2 = 0.227		

Note: *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

Source: Computed by Author.

Table 3 shows that the Random Effects Model (REM) is more appropriate when the F test is significant at the 1% level (Prob > F = 0.000) and the Hausman test has no statistical significance (Prob>chi2 = 0.227). Based on this basis, the author will conduct an estimate of the research model based on the estimated results using the Random Effects Model (REM) method.

Table 4: Testing results of multicollinearity

Variable	VIF
DCP	1.01
SMC	1.00
SIZE	1.02
Mean VIF = 1.01	

Source: Computed by Author.

Table 4 shows that the research model has multicollinearity, which is considered as not serious (VIF <10).

Table 5: Results of testing the variance of heteroscedasticity and autocorrelation

Heteroscedasticity test	Autocorrelation test
chibar2(01) = 47.95 Prob > chi2 = 0.000***	F(1, 34) = 0.731 Prob > F = 0.398

Note: *** indicates significance at the 1% level. (Source: Computed by Author).

The model is free of autocorrelation (Prob > F = 0.398). However, heteroscedasticity really exists in the model (Prob > chi2 = 0.000) (Table 5). Hence, the GMM estimation strategy is employed to control for heteroscedasticity and potential endogeneity.

Table 6: Model estimation results by GMM method

ROA	Coef.	P> z
Constant	-31.178	0.000***
DCP	0.147	0.064*
SMC	-0.082	0.019**
SIZE	0.789	0.000***
Significance level	Wald chi2(2) = 30.14 Prob > chi2 = 0.000***	
Arellano-Bond test for AR(2) in first differences	z = 0.05 Pr > z = 0.963	
Sargan test	chi2(9) = 10.21 Prob > chi2 = 0.334	

Note: *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

Source: Computed by Author.

The estimated results by using the GMM estimator is significant at the 1% level (Prob > chi2 = 0.000). Sargan test also reveals that the adopted instruments are suitable (Prob > chi2 = 0.334) (Table 6). therefore, it can be concluded that the results by estimating the model using the GMM are valid.

Thus, domestic credit to private sector (DCP) exerts positive (0.147) impact on firm performance (ROA) at the 10% level of significance. Concurrently, stock market capitalization (SMC) is negatively (-0.082) correlated to firm performance (ROA) at the 5% significance level. It can be deduced that firm performance is more influenced by developments in the banking system than by those of the stock market. Further, the results also confirm the impact of firm size (SIZE) on firm performance (ROA) is positive (0.789) and significant at the 1% level.

Hence, the research model is estimated by

$$ROA_{it} = -31.178 + 0.147 DCP_t - 0.082 SMC_t + 0.789 SIZE_{it} + \varepsilon_{it} \quad (2).$$

The findings indicate that growth in the banking sector plays a major role in helping firms promote their access to credit as well as their performance. This is consistent with what has been found in a majority of earlier studies. According to them, developments in the banking system facilitate real estate enterprises in access to credit, and they can, in turn, expand their investment and enhance the performance. Furthermore, households find it easier to access to credit, thereby increasing their consumption, investment, and housing demands concurrently. This brings real estate companies more consumed products, in turn improving the performance.

Moreover, the study also reveals an unprecedented finding which is the negative linkage between stock market capitalization (SMC) and firm performance (ROA). Hence, what is really positively associated with the performance of real estate companies is not only stock market

development. It is because firms with large capitalization in the Vietnam stock market tend to make low trading volume. Meanwhile, the number of listed real estate companies in the Vietnam stock market is still limited. More than that, with big growth in the stock market, investors intend to allocate their investment to the stock market (with the high growth rate) instead of the real estate market. It can thus be concluded that the Vietnam stock market does not perform a good role in supplying medium and long-term capital to the real estate market. The stock market even exerts a negative influence on the real estate market as well as firm performance.

5. CONCLUSION

The paper achieved its target in finding the impact of the banking system and stock market on the performance of real estate firms in Vietnam. Particularly, the paper confirms the positive effect of domestic credit to private sector on firm performance. This finding corroborates what has been previously reported. Further, the author also reveals an unprecedented result when stating that the performance of real estate companies is more influenced by the banking sector than by the stock market. This is suitable for Vietnam, a developing country with a specific-major role of the banking system in supplying the capital to the economy as well as the real estate market. Based on these, Vietnam's authorities can propose suitable policies to promote sustainable growth in the banking sector, stock market, and real estate market. For example, (1) It is necessary for banking system to improve their capital supply to real estate market as well as their control for credit risks to assure an effective capital use in real estate market; (2) Stock market also needs restructuring in the direction of promoting liquidity, establishing and fostering real estate investment funds, thereby contributing substantially to growth in real estate market.

The paper has greatly succeeded in giving first empirical evidence on the effect of the banking sector and the stock market on the performance of real estate firms in Vietnam. However, as its limitations, the linkage between firm performance and some control variables, namely economic growth, interest rate, and firm capital structure has not been analyzed yet. This may be an interesting proposal for future research.

6. AVAILABILITY OF DATA AND MATERIAL

Information used and generated in this work is available by contacting the corresponding author.

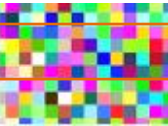
7. REFERENCES

- Beck, T., Demirguc-Kunt, A., Laeven, L., & Maksimovic, V. (2006). The determinants of financing obstacles. *Journal of International Money and Finance*, 25, 932-952.
- Bencivenga, V.R., & Smith, B.D. (1991). Financial intermediation and endogenous growth. *Review of Economic Studies*, 58(2), 195-209.
- Bui, T.N. (2019a). Inflation and stock index: evidence from Vietnam. *Journal of Management Information and Decision Sciences*, 22(4), 408-414.
- Bui, T.N. (2019b). The Role of Financial Development in the Vietnam Economy. *WSEAS Transactions on Business and Economics*, 16, 471-476.

- Bui, T.N. (2020a). Supply chain finance, financial development and profitability of real estate firms in Vietnam. *Uncertain Supply Chain Management*, 8(1), 37-42.
- Bui, T.N. (2020b). Stock holding decisions of foreign investors in emerging stock markets: A case study in Vietnam. *Management Science Letters*, 10(3), 625-630.
- Bui, T.N. (2020c). Domestic Credit and Economic Growth In ASEAN Countries: A Nonlinear Approach. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*. 11(2), 11A02N: 1-9.
- Chauvet, L., & Jacolin, L. (2017). Financial Inclusion, Bank Concentration, and Firm Performance. *World Development*, 97, 1-13.
- Dehejia, R.H., & Lleras-Muney, A. (2007). Financial development and pathways of growth: state branching and deposit insurance laws in the United States, 1900-1940. *Journal of Law and Economics*, 50(2), 239-272.
- Doytch, N., & Uctum, M. (2011). Does the worldwide shift of FDI from manufacturing to services accelerate economic growth? A GMM estimation study. *Journal of International Money and Finance*, 30(3), pp. 410-427.
- Fafchamps, M., & Schündeln, M. (2013). Local financial development and firm performance: Evidence from Morocco. *Journal of Development Economics*, 103, 15-28.
- Fowowe, B. (2017). Access to finance and firm performance: Evidence from African countries. *Review of Development Finance*, 7(1), 6-17.
- Greenwood, J., & Jovanovic, B. (1990). Financial development, growth, and the distribution of income. *Journal of Political Economy*, 98(5), 1076-1107.
- Guiso, L., Sapienza, P., & Zingales, L. (2004). Does local financial development matter?. *Quarterly Journal of Economics*, 119(3), 929-969.
- King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics*, 108(3), 717-737.
- Lee, M. (2015). How Did Financial Development Affect the Performance of European Firms Before and After the 2008 Credit Crisis?. *Eastern European Economics*, 53(6), 514-528.
- Levine, R. (2005). Finance and growth: theory and evidence. *Handbook of Economic Growth*, 1, 865-934.
- Levine, R., Loayza, N., & Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics*, 46(1), 31-77.
- Love, I. (2003). Financial development and financing constraints: International evidence from the structural investment model. *Review of Financial Studies*, 16, 765-791.
- O'Toole, C., & Newman, C. (2017). Investment Financing and Financial Development: Evidence from Viet Nam. *Review of Finance*, 21(4), 1639-1674.
- Pradhan, R., Arvin, M., Hall, J., & Bahmani, S. (2014). Causal nexus between economic growth, banking sector development, stock market development, and other macroeconomic variables: The case of ASEAN countries. *Review of Financial Economics*, 23(4), 155-173.
- Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. *American Economic Review*, 88(3), 559-586.



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THE MEDIATING ROLE OF TECHNOLOGY BETWEEN STUDENTS' ATTITUDES AND ENGAGEMENT TOWARDS SCIENCE: A QUANTITATIVE STUDY OF STUDENTS' PERCEPTION

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ABSTRACT

The attitude of students towards science is an important issue around the world. This study is an effort to enhance student's engagement by increasing their interest in science through technology. This study aimed to find the mediating role of technology between students' academic engagement and their attitude towards science. We conducted a mediation analysis on 400 completed questionnaires filled by science students of wah Cantt, Pakistan. The surveys were distributed among the science students of matriculation, including the 9th and 10th class of 15 randomly selected secondary schools. This study explored the mediating role of technology attitude for learning as a mediating variable between students' academic engagement and students' attitudes towards science. The results showed that a technology attitude for learning is a partial mediator between students' academic engagement and students' attitudes towards science. Further, the study also showed the levels of students' academic engagement, students' attitude, and technology attitude for learning is prominent in male students as well as 10th class students as compared to females and students of 9th class.

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1. INTRODUCTION

Education is a process that develops all individuals' capabilities to fulfill one's responsibilities in society. Investment in school leads to higher economic growth (Bridsall, 1999) through increasing innovation and technological changes in life. The quality of human resources plays a critical role in nations' progress (Khalid & Khan, 2006), which is strengthened by the standards of its educational system. Governments, schools, and teachers set these standards. For higher quality education,

everyone must be highly skilled and professional. Teachers need educational expertise and skills. It can also help teachers to face the challenge of new technologies in teaching as different subjects of science need different skills for effective teaching and learning process.

Secondary school education connects primary education and working life. Secondary school shapes the future education and job by classifying into two significant categories called Science and Arts. Secondary school education develops attitudes, values, and skills required for socio-economic development. Technology is changing rapidly and transforming society as well. The role of science in the scientific and technological development of the nation needs not to overemphasize. That is why science is a compulsory subject at the primary and middle level.

In Pakistan, science is taught as a compulsory subject from grade one to grade eight, after that students may choose their field between sciences and arts. If they choose science, they further study the subjects physics, chemistry, and biology. At the high school level (SSCI and SSII), the proportion choosing the science option is only about 35 percent, which is lower than the estimated target decided by the government.

Secondary school, as a crucial stage of the education system, is traditionally academic and evaluated by an exam (Olssen & O'Neil, 2004). Education is an activity of learning and teaching, so teachers and students need to be involved equally. However, Students' education not only depends on the environment, curriculum, and teacher, but it is also very much dependent on their academic engagement, feeling, and perception about the subject they study. Student engagement is one of the most crucial elements of classroom learning. The issue of student disengagement with the subject of science is a matter of concern for educators both internationally and nationally (Fensham, 2004). The Relevance of Science Education Project (ROSE) identified key affective dimensions related to student engagement includes students' attitudes towards science.

Student's attitudes toward science and their teachers both work side by side in a given learning environment. If students' perspective is negative, they may perform poorly. Thus, Students need to develop a positive attitude toward science subjects and their teachers need to enhance the development of a strong foundation of science. Donovan (1967) stated that it is the attitude developed by the students who are likely to stimulate or stop further study of science.

The attitude of students towards science has been a center of interest in the field of science education for over the last four decades. Declining interest in science has been causing a problem in learning science because it affects the focus of a student in learning (Bae, 2002). A lot of research have been done on students' attitude towards science (Barnby, Kind, & Jones, 2008; Simon, 2021) and have shown a continuous decline of school students in science (Anderhag et al., 2016; Dawson, 2000; Osborne et al., 2003; Potvin & Hasni, 2014). According to students after primary school, they feel more detached with science and find it more challenging to relate to practical life (Tytler et al., 2008). This declining attitude has been found in the starting of the elementary level of schooling (Kerr & Murphy, 2012; Pell & Jarvis, 2001) or secondary schools (Anderhag et al., 2016; Barnby et al., 2008; Häussler & Hoffmann, 2002; Jonathan Osborne et al., 2003).

According to Haladyna & Shaughnessy (1982), students' attitudes toward science is determined by the teacher, student, and learning environment. Self-related factors like feelings and habits (Haste, 2004; Lemke, 2001; Roberts, 2002), teachers related factors such as teaching practices, teacher support, feedback, innovative teaching and learning strategies (Anderhag et al., 2016; Breakwell & Beardsell, 1992; Myers III & Fouts, 1992) and teachers' confidence in teaching science (Tytler et al.,

2008) significantly affect the students' attitude for science learning. Learning environment factors including School, classroom activities, the science curricula, or lab, students' relations with each other determine students' attitude towards science (Myers III & Fouts, 1992; Osborne et al., 2003).

In some studies, boys have positive attitude than girls and vice versa (Abbas et al., 2011; Weinburgh, 1995; Beauchamp & Parkinson, 2008; Dawson, 2000; Hill et al., 2010; Jones et al., 2000; Osborne & Simon, 2009; Schibeci, 2008; Weinburgh, 1995). Teachers should be confident in teaching science to improve the way of teaching science (Tytler et al., 2008). Further cultural, ethnicity, parental, religious have been found to be critical influences on attitudes toward science (Anderhag et al., 2016; Breakwell & Beardsell, 1992; Christidou, 2006; Dawson, 2000; Khishfe & BouJaoude, 2016; Kidman, 2010; Logan & Skamp, 2008; Lyons, 2006; Osborne et al., 2003). Few studies have also reported that students' knowledge about science at the primary level and Parental involvement also plays a crucial role in the development of scientific attitudes of students in later years of schooling for science (Tytler et al., 2008, Abbas et al., 2011; George & Kaplan, 1998; Wang & Wildman, 1995).

Therefore, the problem of negative attitudes toward science may originate from the primary level, and the solution should be started as early as possible with science when students are more receptive to new impulses (Anderhag et al., 2016). For this purpose, science subjects' curriculum is needed to be more appealing to students, through adding engaging, practical experiences (Barmby et al., 2008; Christidou, 2006). Besides, a considerable amount of international attention has been giving to the ICT for contributing immensely to economic, social, and educational change (R.B., 2008; Willinsky, 2014).

The usage of ICT in students' learning environment is considered as an essential factor for students' engagement. In the 21st century, the world is developing in various directions and introducing complex demands in careers, which is no longer attainable through old learning environments and learning paradigms (Avgerinou, 2015). ICT as a fundamental component of general education provides opportunities to students to develop valued skills and abilities including the ability of problem-solving, creative thinking, collaborating and innovating, as these competencies are vital for working 21st-century workplace (Cisco, 2011) through re-energized educational spaces, new curriculum as well as delivery methods. Thus the application of innovative information and communication (ICT) technologies facilitate educators in teaching and learning (Wilson & Boldeman, 2012).

2. LITERATURE REVIEW

Studies have shown that ICT is making significant transformations in students' learning, and Students using ICT facilities have higher learning gains. The learners in the 21st-century are called 'digital natives' because they are more accustomed to the recent technologies than the previous generation. The use of ICT at a young age is frequent as a source of information, entertainment, and social communication like blogs, wikis, podcasting, and social networking, etc. Information and communication technologies (ICT) have the power to engage disengaged students through the Internet, mobile phones and devices, games, digital photography, music, etc. (Wilson & Boldeman, 2012). However, there is very little use of ICT in classroom learning.

Hassan & Sajid (2012) confirmed the existence of barriers at various levels of teaching and

learning to the integration of Information and Communication Technologies (ICTs) at the secondary level learning in Punjab, Pakistan. The participants showed positive perceptions about the integration of ICT into their teaching and learning, and Administration and ICT coordinators highlighted many barriers. The study emphasized the infrastructure, curriculum up-gradation, and teachers' training for better ICT integration in education at the secondary level.

On the other hand, (R. Abbas, Ashraf, Bowra, & Ahmad, 2011; Shah, Mahmood, & Harrison, 2013) explored the Pakistani students' attitude towards science learning through the scale of attitude towards science learning (AtSL). The results showed an increase in students' attitudes towards science learning with the change in grade, and girls were more inclined towards science learning than boys. Paternal education, occupation, and students' locality may affect students' attitudes for learning science; however, maternal education and occupation cause significant differences in attitudes towards learning science. (Anwar & Bhutta, 2014) concluded that student engagement is compulsory in science learning in order to keep their attitudes positive.

There are several studies relevant to ICT, students' attitudes towards science, and student engagement, but none of the studies has explained ICT as a mediator between students' attitudes towards science, and students' academic engagement. This study is motivated by the fact that a strong foundation in essential Science content and skills can enhance the students' interest in science learning through ICT integration (Jonathan Osborne et al., 2003). This paper tried to fill an identified gap in the research field by providing a mediating role of ICT in science learning for engaging diverse young students in science class at the secondary level.

3. CONCEPTUAL BACKGROUND

There is not a significant method to measure the impact of ICT on students' engagement. However, a bunch of literature has identified the substantial effect of ICT integration on the students, teachers, learning environments, policies, procedures, as well as pedagogies according to (Newhouse, 2002). There are several dimensions through which ICT can improve student learning. It includes students' ICT competence, engagement, learning outcomes. Learning Environment Attributes Teacher Professional ICT Attributes and School ICT Capacity. However; the impact of ICT integration on student engagement is still ambiguous. There are contradictory views regarding the use of ICT in education. The integration of ICT is still weak because of the rapid evolvement of technology. Currently, Pakistan is not only facing difficulties in the implementation of effective learning management systems in schools but also students do not have proper access to technology.

There is a growing body of research related to student attitudes and how they relate to student engagement. ICT is considered as a major factor affecting Student engagement. The intricacy of interrelationships between student engagement and student attitudes has forced to investigate other factors like the usage of technology for learning science. The use of computers and the internet makes students more motivated and attentive in class (Balanskat, 2006). Personal use of technology at home helps students to use in school in a better way more recurrently and with more confidence as compared to those students who don't use a computer or internet at home (Underwood, 2009).

4. METHODOLOGY

The present study employed the quantitative method. The questionnaires for the present study were adopted from different studies to assess the mediating role of technology between students'

attitudes towards science and academic engagement at its best. We used simple random sampling for selecting schools and students.

5. A SAMPLE OF THE STUDY

The city of Wah Cantt was selected from the province of Punjab. An equal number of girls and boys' schools were chosen from the city Wah cant. The population of the study is science students (SSC) from secondary school, specifically of 9th and 10th classes SSCI and SSCII, also known as part I and part II students. We used simple random sampling for selecting schools among 44 schools with 1300 faculty members and over 40000 students registered with the Federal board in Pakistan (FBISE). We distributed 450 questionnaires among secondary school science students of 15 randomly selected schools. A total of 400 completed questionnaires were used in the analysis.

5.1 DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

The survey method was used to collect the data. The researcher administered the questionnaire, and the said data was collected personally. Most of the respondents returned the questionnaires on the same day, but a few asked to return the day next. Students were asked to fill the survey for the given close-ended questions. Demographic factors included gender and level of education at SSC (SSCI/SSCII). All the students were science students.

5.2 INSTRUMENTS

In this study, we used students' attitudes towards science as independent, student engagement as a dependent, and students' attitude towards technology as mediators. The mediating analysis in the Spss21 extension of Preacher and Hayes was done to examine the potential of technology or ICT as a mediator.

5.3 STUDENTS' ATTITUDE SCALE TOWARDS SCIENCE

The data for students' attitudes towards science was measured through Simpson – Troost Attitude Questionnaire (STAQ) (Liaghatdar et al., 2011). This questionnaire consists of 44 items on 5-point Likert-type scales as Always, Frequently, Usually, Rarely, and Never corresponding to the factors determining the attitude of science students at the secondary level.

5.4 STUDENTS' ACADEMIC ENGAGEMENT SCALE

Students' academic engagement scale was taken as outcome variable based on Utrecht Work Engagement Scale-Student (Schaufeli, Martínez, Pinto, Salanova, & Bakker, 2002). The UWES-S is a 14 items scale that covers passion, dedication, and concentration. The 5-point Likert-type scales as Always, Frequently, Usually, Rarely, and, Never were used.

5.5 TECHNOLOGY ATTITUDE SCALE FOR LEARNING

Technology attitude scale for learning as a mediator of this study measured the access, perceptions, and learning with technology. The Items 1-11 of the survey are related to the students' access to technology for indicating their level of access to different types of technologies. The access for technology was measured through a 3-point Likert scale as 1=no access, 2=limited access, and 3=full access. Items 12-19 of the survey helped to measure the students' perceptions of learning with Information and Communication Technology. 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) was employed for each item in order to indicate the degree to which they feel towards technology-based learning. Attitudes towards the use of technology for

learning Items 20-28 measured students' attitudes towards the use of technology for learning; for each item, a 5-point Likert scale was used (Chenoby, 2014).

6. MEDIATION ANALYSIS

The mediating analysis was conducted with the help of the Spss21 extension of Preacher and Hayes to capture the mediating part of technology attitude for learning between students' academic engagement and students' attitudes towards science where students' academic engagement and students' attitude towards science were treated as dependent and independent respectively.

7. RESULTS

7.1 PARTICIPANT CHARACTERISTICS

The data showed an almost equal number of female and male students in science class with a little number of boys greater than girls. As out of the total number of science students participants, 204 boys and 196 are girls. Participants' characteristics were observed not only for all participants but also at gender and SSCI level as SSCI and SSCII.

7.2 CORRELATION ANALYSIS

Descriptive statistics and correlations are given below. Pearson's correlation coefficients were used to examine correlations. Table 1 showed the results of descriptive statistics and the correlation between students' academic engagement, students' attitude, and technology attitude for learning. The correlation analysis showed that students' academic engagement, students' attitude, and technology attitude for learning are significantly and positively correlated with each other.

Table 1: Descriptive statistics and correlations for Students Academic Engagement, Students Attitude, and Technology Attitude for Learning (N=400)

Scales	Mean \pm SD	1	2	3
Students' Academic Engagement	37.033 \pm 2.79	1	-	-
Students' Attitude towards science	131.258 \pm 9.29	.588**	1	-
Technology Attitude for Learning	69.163 \pm 6.46	.603**	.166**	1

** . Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

8. MEDIATION ANALYSIS

The mediating analysis was conducted to capture the mediating part of technology towards learning. In mediation analysis, students' academic engagement as an outcome, students' attitude towards science as an independent variable while technology attitude for learning was taken as mediator.

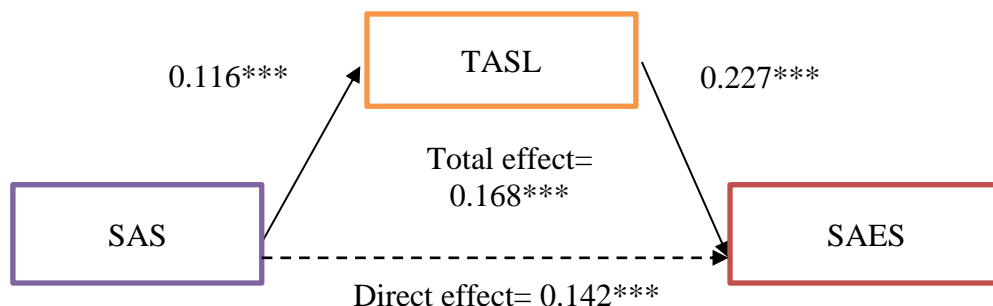


Figure 1: Mediating analysis, Students' Academic Engagement as an outcome, Students Attitude as Independent variable and Technology Attitude for Learning as Mediator

Figure 1 showed that technology attitude for learning partially mediate the relationship between students' attitude and students' academic engagement where

TASL = Technology attitude scale for learning

SAS = Students' attitude for science

SAES = Students' academic engagement scale

8.1 INDEPENDENT SAMPLES T-TEST

The independent samples t-test tests were used to compare the differences among Students' Academic Engagement, Students' Attitude towards science and Technology Attitude for Learning at gender as well as class level.

Table 2: Gender-Based Differences among Students' Academic Engagement, Students' Attitude and Technology Attitude for Learning

Variables	Male		Female		T	P
	(n=204)		(n=196)			
	M	SD	M	SD		
Students' Academic Engagement	37.348	2.80	36.704	2.75	2.318	.021*
Students' Attitude	132.907	7.99	129.541	10.21	3.681	.000***
Technology Attitude for Learning	70.162	7.15	68.122	5.48	3.193	.002**

Table 3: Class-Based Differences among Students' Academic Engagement, Students' Attitude, and Technology Attitude for Learning

Variables	1 st Year		2 nd Year			
	(n=227)		(n=173)			
	M	SD	M	SD	T	P
Students' Academic Engagement	36.621	2.89	37.572	2.57	-3.420	0.001**
Students' Attitude	130.397	9.40	132.387	9.04	-2.134	0.033*
Technology Attitude for Learning	68.282	6.50	70.318	6.24	-3.159	0.002**

Tables 2 and 3 depicted the results of independent samples t-test tests to compare the differences in the levels of students' academic engagement, students' attitude and technology attitude for learning between gender as well as SSC level. The results showed higher levels of students' academic engagement, students' attitude, and technology attitude toward learning in male students as compared to female students. Similarly the levels of students' academic engagement, students' attitude, and technology attitude for learning higher in the students of 2nd-year class that that of 1st-year class.

9. CONCLUSION AND RECOMMENDATION

This study was an effort to increase the level of engagement in science subjects by making it more entertaining through using technology. The best way to engage students can be found by asking students about it. Therefore in this study, the students were asked about their attitudes and level of engagement for science subjects. The questionnaire for showing their attitudes for science included several factors that can probably determine their attitude towards it, like the perception of students about science teacher, teaching method, the environment of science class, study habits for science subjects, likeness or dislikes for science, the attitude of family and friends for science, dedication, and anxiety towards science. Similarly, students can tell accurately how much engagement they feel during studying science. The finding revealed that technology might work as a partial mediator for

science students and thus can enhance their engagement in science by making science more entertaining and enjoyable.

Pakistan is a developing country, and continuously struggling with ups and downs condition so as its education system. In this current situation, the government can't integrate ICT in every school because of the limited budget. However, students do have access to different technology devices outside of school, and they are learning a lot from it. But there is a still need for technology integration in schools like other countries in the world. According to studies, In Pakistan, luckily students have positive for science as compared to the world's declining trend in science. There is just a need to be aligned with the world ICT integration policy set by Millilium development goals so that students can enjoy science and their positive attitude towards it can be maintained. However, this study is just limited to science learning, but it can be applied to any other subjects of secondary education as well as for other specific science subjects at different levels of education.

10. AVAILABILITY OF DATA AND MATERIAL

Information used and generated from this work is available by contacting the corresponding author.

11. REFERENCE

- Abbas, R. Z., Ashraf, M., Ahmad, M., Khalil, U., & Ahmad, Z. (2011). Measuring the Attitude towards Science in Pakistan. *INTERDISCIPLINARY JOURNAL OF CONTEMPORARY RESEARCH IN BUSINESS*.
- Anderhag, P., Wickman, P.-O., Bergqvist, K., Jakobson, B., Hamza, K. M., & Säljö, R. (2016). Why Do Secondary School Students Lose Their Interest in Science? Or Does it Never Emerge? A Possible and Overlooked Explanation. *Science Education*, 100(5), 791-813.
- Anwar, N. P., & Bhutta, S. M. (2014). Students' attitude towards science in lower secondary classes : Comparison across regions. *Journal of Educational Research*, 77-90.
- Avgerinou, S. G. M. D. (2015). Aristeia Leadership: A Catalyst for the i2Flex Methodology. *Educational Policy Analysis and Strategic Research*.
- Bae, M.-J. (2002). *An Analysis of the Psychological Structure of 'Learned Helplessness': A case Study*. Retrieved from
- Balanskat, A., Roger Blamire and Stella Kefala. (2006). *The Impact Report: A Review of Studies of ICT Impact on Schools in Europe*. Retrieved from
- Barmby, P., Kind, P., & Jones, K. (2008). Examining Changing Attitudes in Secondary School Science. *International Journal of Science Education*, 30. doi:10.1080/09500690701344966
- Beauchamp, G., & Parkinson, J. (2008). Pupils' attitudes towards school science as they transfer from an ICT-rich primary school to a secondary school with fewer ICT resources: Does ICT matter? *Education and Information Technologies*, 13(2), 103-118.
- Breakwell, G. M., & Beardsell, S. (1992). Gender, parental and peer influences upon science attitudes and activities. *Public Understanding of Science*, 1(2), 183-197. doi:10.1088/0963-6625/1/2/003
- Bridsall, N. (1999). *Education, Globalization and Demands of the 21st Century*
- Christidou, V. (2006). Greek Students' Science-related Interests and Experiences: Gender differences and correlations. *International Journal of Science Education*, 28(10), 1181-1199.
- Cisco. (2011). *Equipping every learner for the 21st Century*. Retrieved from
- Dawson, C. (2000). Upper primary boys' and girls' interests in science: have they changed since 1980? *International Journal of Science Education*, 22(6), 557-570. doi:10.1080/095006900289660
- Fensham, P. (2004). *Engagement with Science: An international issue that goes beyond knowledge*. Retrieved

from Dublin, Ireland.

- George, R., & Kaplan, D. (1998). A structural model of parent and teacher influences on science attitudes of eighth graders: Evidence from NELS:88. *Science Education*, 93-109.
- Haladyna, T., & Shaughnessy, J. (1982). Attitudes toward science: A quantitative synthesis. *Science Education*, 66(4), 547-563. doi:10.1002/sce.3730660406
- Haste, H. (2004). *Science in My Future: A study of values and beliefs in relation to science and technology amongst 11-21 year olds*. Retrieved from London:
- Häussler, P., & Hoffmann, L. (2002). An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. *Journal of Research in Science Teaching*, 39(9), 870-888. doi:10.1002/tea.10048
- Hill, C., Corbett, C., & St. Rose, A. (2010). Why So Few? Women in Science, Technology, Engineering, and Mathematics. *American Association of University Women*.
- Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, 84(2), 180-192. doi:10.1002/(sici)1098-237x(200003)84:2<180::Aid-sce3>3.0.Co;2-x
- Kerr, K., & Murphy, C. (2012). Children's Attitudes to Primary Science. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *Second International Handbook of Science Education* (pp. 627-649). Dordrecht: Springer Netherlands.
- Khalid, M. K., & Khan, F. M. (2006). Pakistan the State of Education. *The Muslim World*.
- Khishfe, R., & BouJaoude, S. (2016). Lebanese Students' Conceptions of Attitudes Towards Science And Related Careers Based On Their Gender And Religious Affiliations. *International Journal of Science and Mathematics Education*, 14(1), 145-167. doi:10.1007/s10763-014-9587-0
- Kidman, G. (2010). What is an 'Interesting Curriculum' for Biotechnology Education? Students and Teachers Opposing Views. *Research in Science Education*, 40(3), 353-373. doi:10.1007/s11165-009-9125-1
- Lemke, J. L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching*, 38(3), 296-316. doi:10.1002/1098-2736(200103)38:3<296::Aid-tea1007>3.0.Co;2-r
- Liaghatdar, M., Soltani, A., & Abedi, A. (2011). A Validity Study of Attitudes toward Science Scale among Iranian Secondary School Students. *International Education Studies*, 4. doi:10.5539/ies.v4n4p36
- Logan, M., & Skamp, K. (2008). Engaging Students in Science Across the Primary Secondary Interface: Listening to the Students' Voice. *Research in Science Education*, 38(4), 501-527. doi:10.1007/s11165-007-9063-8
- Lyons, T. (2006). The Puzzle of Falling Enrolments in Physics and Chemistry Courses: Putting Some Pieces Together. *Research in Science Education*, 36(3), 285-311. doi:10.1007/s11165-005-9008-z
- Myers III, R. E., & Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude toward science. *Journal of Research in Science Teaching*, 29(9), 929-937. doi:10.1002/tea.3660290904
- Newhouse, C. P. (2002). *A Framework to Articulate the Impact of ICT on Learning*. Retrieved from
- Olssen, M., & O'Neil, A.-M. (2004). *Education Policy: Globalization, Citizenship And Democracy*: SAGE Publications Ltd.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049-1079. doi:10.1080/0950069032000032199
- Osborne, J., & Simon, S. T., R. (2009). *Attitudes toward science: An update*. . Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, California. .
- Pell, T., & Jarvis, T. (2001). Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal of Science Education*, 23(8), 847-862. doi:10.1080/09500690010016111

- Potvin, P., & Hasni, A. (2014). Analysis of the Decline in Interest Towards School Science and Technology from Grades 5 Through 11. *Journal of Science Education and Technology*, 23(6), 784-802. doi:10.1007/s10956-014-9512-x
- R.B., K. (2008). Comparative Analysis of Policies for ICT in Education. In *International Handbook of Information Technology in Primary and Secondary Education*: Springer International Handbook of Information Technology in Primary and Secondary Education, vol 20. Springer, Boston, MA.
- Roberts, G. (2002). *SET for success: The supply of people with science, technology, engineering and mathematics skills*. Retrieved from London:
- Schaufeli, W. B., Martínez, I. M., Pinto, A. M., Salanova, M., & Bakker, A. B. (2002). Burnout and Engagement in University Students: A Cross-National Study. *Journal of Cross-Cultural Psychology*, 33(5), 464-481. doi:10.1177/0022022102033005003
- Schibeci, R. (2008). Attitudes to Science: an update. *Studies in Science Education*, 11 (1984), 26-59. doi:10.1080/03057268408559913
- Shah, Z. A., Mahmood, N., & Harrison, C. (2013). Attitude towards science learning: An exploration of Pakistani students. *Journal of Turkish Science Education*, 10, 35-47.
- Simon, S. (2021). Attitudes to Science and to Learning Science. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 1-6). Dordrecht: Springer Netherlands.
- Tytler, R., Osborne, J. F., Williams, G., Tytler, K., Clark, J. C., & Tomei, A. (2008). *Opening up pathways: Engagement in STEM across the Primary-Secondary school transition. A review of the literature concerning supports and barriers to Science, Technology, Engineering and Mathematics engagement at Primary Secondary transition*. Retrieved from Melbourne: Deakin University. :
- Underwood, J. D. M. (2009). *The impact of digital technology : a review of the evidence of the impact of digital technologies on formal education*. Retrieved from UK: Becta:
- Wang, J., & Wildman, L. (1995). An empirical examination of the effects of family commitment in education on student achievement in seventh grade science. *Journal of Research in Science Teaching*, 32(8), 833-837. doi:10.1002/tea.3660320806
- Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching*, 32(4), 387-398.
- Willinsky, J. (2014). *The new openness in educational research*. Amsterdam, Netherlands: Springer.: In A. D. Reid, E. P. Hart, & M.A. Peters. A companion to research in education
- Wilson, K. L., & Boldeman, S. U. (2012). Exploring ICT Integration as a Tool to Engage Young People at a Flexible Learning Centre. *Journal of Science Education and Technology*, 21(6), 661-668. doi:10.1007/s10956-011-9355-7



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LEGAL AND PHILOSOPHICAL VIEWS OF G.F. SHERSHENEVICH: A RUSSIAN SCIENTIST AND POLITICIAN

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ABSTRACT

This scientific article is devoted to the analysis of philosophical and political-legal concepts of one of the main representatives of Russian liberalism of the late XIX - early. XX centuries Gabriel Feliksovich Shershenevich. The study showed that he considered the main tasks of the philosophy of law to determine the nature of the relationship of universal laws of being with the laws of society, through which legal laws regulate people's behavior. As a result, he points out that there is no single answer to the question about the essence of the philosophy of law.

Disciplinary: Multidisciplinary (Philosophy, History, Law, Political Sciences, Socioeconomics).

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1. INTRODUCTION

The study of philosophical and legal concepts is a difficult but necessary task for legal science. Any typology of the analysis of legal space and time will always be incomplete since it reflects various social systems, the unpredictability of their evolution and the limited possibilities of our knowledge in the conditions of inexhaustible philosophical ideas about the nature of law. Philosophical and legal ideas are always associated with a particular historical era, the level of social development at which they appear and are affirmed, as well as with the answer to the question of why they arise and are implemented in this particular society and at a particular stage of its development. Such a formulation of the question of the essence of the history of philosophy of law allowed Gabriel Feliksovich Shershenevich to form his own vision of its purpose, on the basis of which the most general principles of the law of each era that determine the paradigms and mechanisms of its action in society can be understood and explained.

The urgent problem of the science of law of that time was the search for a distinction between the philosophy of law and the theory of law, therefore, issues of legal dogmatism, as a matter of discussion, gained importance precisely in connection with attempts to abandon the traditional understanding of jurisprudence, replacing it with a philosophical and legal approach. Gabriel Feliksovich believed that the subject of the philosophy of law is the study of law, as it is and what it should be. This requires a general concept of law, revealing its essence, which is achieved through the scientific philosophy of law. The subject of philosophy of law should be the study of the categorical apparatus of legal sciences, including the concepts of the rule of law, legal relations, legal responsibility, state, society, etc.

The philosophy of law at that time was seen as an application of its general principles to jurisprudence, that is, a specific field of humanitarian knowledge. It differs from jurisprudence studying specific legal systems in that it poses and solves their problems at the level of philosophical knowledge and in the context of dialectical development. The specifics of the philosophical and legal approach consist in the study of the most general theoretical and worldview problems of law and the state, analyzed within the framework of forms of social consciousness that have a common nature but differ in the subject of reflection, thereby acquiring the form of philosophical knowledge. In each historical era, within the framework of one philosophizing method, various substantive approaches to understanding the essence of legal phenomena can coexist, such as theocratic, natural-legal, positivistic and others, among which there should be a dominant one. According to Gabriel Feliksovich, changes in the types of philosophical reflection of the essence of the state and law are determined by the dynamics of the political, economic, sociocultural life of society.

2. METHOD

Solving the problem of scientific research of philosophical and legal views of a Russian scientist and politician G.F. Shershenevich demanded the use of various methods. Systemic and philosophical and legal methods allowed us to analyze the life and work of the Russian philosopher and lawyer G.F. Shershenevich, an example of the unity of a scientist and a public figure who made a significant contribution to the development of Russian theory and philosophy of law. The socio-legal and institutional-legal analysis made it possible to identify the features of the process of forming its philosophical and legal views, due to the specifics of the political and socio-economic development of Russia in the late XIX - early XX centuries, as well as ideological trends that reflected the pre-revolutionary sentiments of the intelligentsia. A significant role was played by the dialectical method, the application of which made it possible to reproduce the theoretical and methodological concept of G.F. Shershenevich. He believed that “the very concept of law should undoubtedly be recognized as the supreme and basic concept, and in connection with its essence, questions about its formation, violation of the law, violation of the law, and legal relations created by the law” [3]. Consequently, the definition of the essence of law, its relations with the state and morality, depends on the historical conditions in which they exist.

3. RESULT AND DISCUSSION

3.1. THE PRE-REVOLUTIONARY SITUATION IN THE RUSSIAN EMPIRE OF THE LATE XIX-EARLY XX CENTURIES AS A FACTOR IN THE FORMATION OF THE LEGAL CONCEPT OF G.F. SHERSHENEVICH

The formation of philosophical and political-legal concepts of the late XIX - early XX centuries led to the political arena of the representatives of liberalism, one of which was Gabriel Feliksovich Shershenevich. His life and work are an example of the unity of a scientist and a public figure who has made a significant contribution to the development of Russian theory and philosophy of law. The scientific concept reflecting pre-revolutionary attitudes to the public the content of the political and legal problems of his party. A special period in the political biography of G.F. Shershenevich is associated with the Constitutional Democratic Party, of which he became a member in 1906. As a deputy to the State Duma, he acted as fellow secretary of the Duma, Chairman of the 4th department of the Duma and member of the legislative commission of the party, took part in the development of bills on rights and freedoms, civil equality, personal integrity, etc. In the process of deputy activity, he paid special attention to social legislation, the protection of trade unions, the control of working hours, health protection, insurance of workers and employees, the organization of public charity, etc.

Philosophical and legal views G.F. Shershenevich formed under the influence of discussions that took place in law, the theory of state and law, the sociology of law and influenced the formation of his scientific concepts. In his theoretical views, he was close to the tradition of neo-Kantian philosophical thought, in which at that time special attention was paid to the practical problems of law and the state. Based on the Kantian idea of the rule of law, Gabriel Feliksovich wrote that "the practical task of the philosophy of law is to build the ideal of the legal order in its integrity" [5].

The practical need to uphold the program of the Constitutional Democratic Party led G.F. Shershenevich to actualize the history of the philosophy of law, theory and sociology of law, as well as problems of public law, such as forms of government, constitutional monarchy, the responsibility of the authorities to the people, etc. The set of problems posed and solved allowed Gabriel Feliksovich to contribute to the philosophy of law as a fragment of Russian legal thought, which is of particular importance during the period of democratic transit of Russian statehood. Sharing the views of S.A. Muromtseva, who was considered the founder of the Russian sociological school of law, Gabriel Feliksovich departs from dogmatic jurisprudence, showing the close relationship of legal norms and relations with social reality [6].

Creating a philosophical and legal concept of the essence of state and law, G.F. Shershenevich used the formal dogmatic methodology of legal positivism. Analyzing his work, V.D. Zorkin writes that "from the position of legal positivism, he developed a strict dogma of law, especially Russian civil law, and proposed clear and clearly defined legal constructions of individual institutions. All this met the objectives of jurisprudence in Russia during the creation and development of bourgeois legislation. Therefore, Shershenevich's authority was very high not only in academic circles but also among practicing lawyers" [1]. Studying the laws of positive law, Gabriel Feliksovich comes to the conclusion that it is possible to identify trends in its development in various states, but it is impossible to comprehend the eternal idea of law as a fiction.

The philosophy of law, establishing its concepts, proceeds from positive, that is, existing law, through which one can understand the problems of the state and law from the standpoint of

comparative law. Further G.F. Shershenevich concludes that “science deals with the world of phenomena, and only their study, classification, generalization is possible for it. The study of what constitutes the unknown cause of the phenomena is inaccessible to it, but it is possible, they say, for philosophy, which then becomes metaphysics ”[4]. Passion for the search for ideal eternal law leads to a distraction of philosophical and legal thought from pressing legal issues determined by time and place, that is, the law as it really is.

Gabriel Feliksovich Shershenevich defined the totality of norms or provisions, united by the unity of content or internal communication on the subject of regulation, as a legal institution.

The tasks of the philosophy of law were formulated by him as a study of legal institutions, their classification, totality and codification of law in the process of formalizing social relations. He considered the methods of such analysis not only historical or dogmatic but also sociological, “critical” as a new area of legal analytics. This approach opened up the possibility of moving from an empirical analysis of individual legal phenomena to comparative and sociological generalizations that allowed the author to contribute to the philosophy of law.

Analyzing the transformation of legal views S.A. Muromtseva, he defines it as a consistent movement from the historical school of law to the sociological, indicating that objective and subjective law are not two sides of one concept, as representatives of sociological jurisprudence claimed, but two independent concepts. Since subjective law corresponds to objective law, which can exist without subjective law and that does not correspond to the nature of neo-Kantianism, the concepts of subject and object of law can have a relative character, constantly changing places. Objective law, according to G.F. Shershenevich, is the basic concept of positive law, and the subjective is derived from it, reflecting personal and public interests and needs. This inconsistency manifested itself in this matter, caused by the internal struggle, on the one hand of the philosopher, and on the other of the lawyer, in which the author's legal point of view prevailed.

3.2 LAW AND MORALITY: DELIMITING THE SPHERES OF REGULATION IN THE WORK OF G.F. SHERSHENEVICH

Gabriel Feliksovich shared the concepts of law and morality, considering them different due to the public relations reflected and regulated by them. Unlike law, moral standards are social in nature and present their demands on a person. A person's behavior is ensured by the social impact of the moral law on him, existing not in us, but outside of us. He wrote that “the resolution of questions about the essence of law, about its relation to the state, to morality, depends on the historical conditions under which these questions are posed” [4]. Consequently, immutable morality can be neither in nature, nor in society, and all moral concepts are relative and historically changeable. The criteria of morality are not in the behavior of a person but in the assessment of his society. Such behavior should be socially useful, and, consequently, prohibitions on those actions that threaten the public good are necessary.

The main characteristics of law as a regulator of public relations, Gabriel Feliksovich attributed his ability to influence the behavior of individuals; coercive nature; connection with state authority; the establishment of law and order, etc., since these elements form the concept of law, as norms of proper behavior. He was against the broad interpretation of the law and its extension to relations regulated by morality, which creates a false impression of a more effective legal regulation than moral regulation. The task of the philosophy of law, from his point of view, should be a clear distinction between the areas of regulation of law and morality. The law may ascribe to itself what is

actually supported by morality, but this does not contribute to the rule of law. According to Gabriel Feliksovich, the morally due is the manifestation of subjective assessments of law, volatile and not generally binding, therefore the subject of philosophy of law is not subjective assessments of law, but the law itself, as a fact of people's real-life activity.

Moreover, G.F. Shershenevich believed that understanding the essence of law is impossible without a sociological analysis of its manifestations in the life of society, which should be studied by various social sciences. The opposition to the current law of the “ideal law”, he rejected, considering them interconnected. The nature and essence of natural law throughout history have undergone various interpretations, including methodological, historical or political aspects. In his opinion, natural law supplements the existing one and applies when the laws are “silent” or they are clearly contrary to justice and common sense. Along with this, G.F. Shershenevich criticized the concept of changing natural law that existed at that time, considering it scientifically untenable, seeking to replace the existing law with ideology. He wrote that “in any case, the old and the new directions of natural law unilaterally limit the tasks of the philosophy of law to the formulation of the ideal and ignore the study of positive law in its main points. Meanwhile, having only penetrated into the essence of law as a real phenomenon, one can dare to use this tool to build an ideal order ”[4]. Contrasting the existing law with the “ideal” leads, in his opinion, to the complication of legal relations, the confusion of law with other social norms. In general, G.F. Shershenevich defended the position of legal positivism, identifying the general theory and philosophy of law with formal dogmatic jurisprudence.

The source of law in the philosophy of G.F. Shershenevich is a state with legal means to force others to reconcile their behavior with the will of the ruling elites. At the heart of power, in his opinion, is a special mentality consisting of fear, faith and the hope that obedience can be beneficial. The basis and source of political power is state power as a force standing above the law, which is the legal execution of political order. In this regard, the main problem of his philosophy was social and legal issues, due to which the rational principles of law proved impossible to implement in Russia. This determines the appeal of G.F. Shershenevich, like other Russian philosophers of the law of the time to the problem of traditional societies and legal systems. At the same time, he saw the errors of traditionalist systems in the fact that the legislator determined the trends of the time, creating a code imbued with the principles of enlightened absolutism, while life strove to free the individual from the tutelage of the state and provide him with great rights and freedoms.

The practical conclusion of G.F. Shershenevich was in the need for codification of law as a tool for the modernization of social relations in Russia, through their unification, elimination of class division, rationalization as the establishment of legal equality of all members of society and overcoming legal nihilism. He associated the transformation of state power with the separation of powers and the liberalization of public relations, seeing this as the development of Russian constitutionalism. He defined the new law as a set of legal norms establishing private relations of individuals in society, and he saw the content of legal norms in the rules governing coercion between citizens and the state.

4. CONCLUSION

Despite the considerable time separating the work of G.F. Shershenevich from modern times, his

interpretation of the philosophy of law can become a guide, both for students and those who are interested in it. In "History of the Philosophy of Law" [4] he shows how philosophical ideas associated with a certain historical era appear and are approved precisely in this society and at a specific stage of its development. Such a formulation of the question allowed him to show his vision of the development of the history of the philosophy of law, on the basis of which the most general principles of the law of each era that determine its functions in society can be understood and explained.

Modern philosophy of law is an abstract legal discipline, the main purpose of which is to show law as a special form of public consciousness, including political and legal institutions, legal norms and regulations formally enshrined in laws. It is designed to provide answers to questions about the recognizability of the nature of the state and law, the relationship of law and morality, the general principles of interaction of the theory of law, laws and legal policy. These same problems, reflected in philosophical and legal thought, enable Gabriel Feliksovich to show the correlation and features of the traditional and contemporary directions of its development.

From a formal legal point of view, the law is a system of norms that are mandatory for implementation in a given society, but along with such a purely legal definition, a more general interpretation of its essence as a form of public consciousness is necessary. The unity of law for all eras and countries is that it acts as a regulator of social relations. At the same time, this system can be oriented both to the preservation of existing orders, their reasonable transformation, and to the transformation of one legal system into another. The nature of the functional orientation of law is determined by the values of a particular society, associated with philosophical, moral, mental and other worldviews about it. The history of the philosophy of law allows us to understand the evolution of the principle of formal legal equality while maintaining it in any legal system. The historical stages of the development of the state and law correspond to its scale and its measure of freedom, the range of subjects and legal relations, that is, its content of the principle of legal equality.

G.F. Shershenevich believed that the philosophy of law does not give new content to legal concepts, its purpose is to determine the essence of the phenomena of social life, which determines its theoretical and practical orientation. He rightly noted that "the theoretical task of the philosophy of law is a critical study of all those main concepts that underlie the legal sciences and which they are accepted for the most part dogmatically" [3]. The philosophy of law shows how the ideals of the legal order change in history, how they relate to the environment that generated them. In principle, there may be a mismatch between ideal ideas and trends of the time, and then it can manifest itself in the individual direction of thought and will of the author of the ideal. Therefore, when studying various types of legal understanding, it is necessary to take into account the conditions in which philosophical doctrine appears, what is the individuality of its creator, as well as the relationship between new and previous paradigms.

Analyzing the problems of the history of the philosophy of law, which had relevance in different eras from Ancient Greece to Hegel's "Philosophy of Law", G.F. Shershenevich formulated its tasks as an independent science. Both in the past and at present, its main task is to form a value-based attitude of people to law and the state, affecting human destinies, rights, and freedoms. The main tasks of the philosophy of law are to determine the nature of the relationship of universal laws of being with the laws of society, through which legal laws regulate human behavior. As a result, G.F. Shershenevich comes to the conclusion that there is no definite answer to the question about the essence of the

philosophy of law, since “philosophers do not want to go down to the earth, and lawyers do not want to raise their eyes from the earth higher” [2]. However, to date, discussions continue about the nature and meaning of the philosophy of law, its place in the system of legal knowledge.

5. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

6. REFERENCES

- [1] Zorkin V.D. Positivist theory of law in Russia. *Moscow*, 1978.
- [2] Russian philosophy of law: philosophy of faith and morality (Anthology) / Comp. A.P. Albov, D.V. Maslennikov, A.I. Chislov, S.V. Filippov. *St. Petersburg*, 1997.
- [3] Shershenevich G. F. General theory of law. *Moscow*, 1910.
- [4] Shershenevich G.F. The history of the philosophy of law. *St. Petersburg*, 2001.
- [5] Shershenevich G.F. History of philosophy of law. *St. Petersburg*, 1907.
- [6] Shershenevich G.F. The general theory of law - *Moscow*, 1911.



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AN APPRAISAL OF SUPPLY CHAIN MANAGEMENT MATURITY IN THE OIL AND GAS SECTOR OF PAKISTAN

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ABSTRACT

Oil and gas (O&G) supply chain management faces various challenges owing to its complexity and inflexibility mainly because of the rigid procurement process, long lead-time, complex multi-modal transportation and distribution involved. The same challenges are equally true for Pakistan's O&G industry. Although in the developing stage, the O&G supply chain has gained some level of maturity. As such, this study appraises the maturity level of supply chain and operation management practices of the Pakistan oil and gas industry using the Supply Chain Maturity Assessment Test (SCMAT). To carry out the assessment, a quantitative survey was conducted with 13 companies in the O&G industry of Pakistan. From the responses regarding the variables already defined in the SCMAT, companies were assessed to develop their maturity points and maturity levels. It is concluded that a higher score on variables of maturity demonstrates a higher level of maturity that in turn represents a more open and empowered management style.

Disciplinary: Management Sciences, Supply Chain Management.

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1. INTRODUCTION

The O&G industry has an extensive worldwide supply chain that involves transportation at the national and international levels, inventory management, information technology management, and import-export facilitation. However, the supplied commodity of the chain is scarce, and the industry is experiencing geographical challenges regarding O&G exploration in the world's harshest environment. The rise in global demand for O&G and the inflexibility associated has made supply chain management (SCM) more multifaceted and more challenging.

However, best practices of the supply chain provide a significant strategy to O&G companies to leverage their capabilities and improve their performances through sharing knowledge and abilities

acquired in the collaborative setting (Lockamy III & McCormack, 2004; Mentzer et al., 2001). But the question is on how to determine the level of capabilities the companies have acquired in the organizational processes. One way to determine supply chain capabilities is to analyze how mature the company SCM practices are. Maturity is described in terms of its wide-ranging collaboration across the supply chain with its partners in order to execute adopted integrative practices. As proposed by Bowersox and Daugherty (1995), the underlying idea is to attain an advanced level of supply chain maturity.

Extensive research has been conducted to delineate and assess supply chain performance through maturity models (Gunasekaran et al., 2001). By using these maturity models, one can measure and appraise the present status of internal and external collaborative processes of a company and to propagate the best practices of the supply chain (Lockamy III & McCormack, 2004; Simon et al., 2015).

Following the innovative work on the Quality Management Maturity Grid by Crosby (1980), numerous studies have been conducted to develop maturity models. Kohlegger, Maier, and Thalmann (2009) have identified more than 70 maturity models in software and system engineering area. A major influencing factor of many of the existing maturity models is the “Capability Maturity Model” (CMM) (Battista & Schiraldi, 2013; Netland et al., 2007). However, the focus of maturity models has now widened and the trend has dissipated domains more than 20 including project, risk, product development, human resources, process and SCM (Wendler, 2012).

Among the many maturity models, the most known for the supply chain is the “supply chain management process maturity model”, describing the maturity of a business supply chain (Lockamy III & McCormack, 2004). The model uses the “Supply Chain Council’s SCOR framework” to assess the intensity of process integration in a business chain of supplies. Most recently, Simon et al. (2015) proposed a model for the evaluation of supply chain maturity. Another contribution is the “supply chain capability maturity model” (SCCMM) developed by Giachetti and Garcia-Reyes (2010). The model was tested in a number of Mexican firms to verify its ability in identifying the maturity levels for the firms. The Logistic Maturity Model (LMM) proposed by Battista and Schiraldi (2013) has the purpose of giving guidelines for process continuous improvement, i.e. mapping as-is logistic processes and establish a roadmap for the improvement and reaching desired logistic performance. The authors characterize the model as a specific maturity model with a focus on logistics.

In short, mostly the existing models are helpful to measure the quality of specific processes: collaboration, degree of integration, continuous improvement and so on, but not comprehensive enough for the industry to adopt largely and handle all decision areas of operation strategy. Moreover, in the authors’ knowledge, the O&G industry lacks the supply chain maturity model for assessing the industry's best practices in a coherent manner.

The emphasis of this research is, therefore, to appraise the SCM maturity in the O&G sector, and to uncover the decision areas where best practices can be adapted to improve and develop the effective oil supply chain. In pursuance to the overall objective, a structured methodology is used to appraise current SCM practices and issues through appropriate measures of maturity model which allows an analysis of the overall O&G industry’s adherence to SCM best practices.

2. OIL AND GAS INDUSTRY

Energy consumption is on the rise (IEO, 2016). The demand for energy from 2004-2030 is

predicted to enhance by 1.7% per year that will reach 15.3 billion tons of oil per annum. This rise in energy demand will be equivalent to two times the amount of current demand (Aminuddin & Mazari, 2004). Growth in energy trade is therefore projected in the near future and specifically, a substantial increase in the imports of the main O&G consuming countries will be very high. As the economic tendency of a country is closely linked with the supply of oil (Hilmola, 2011), any disruption in the supply will adversely affect the economies. However, the instability in the O&G market is also remarkable due to several erratic factors, for instance, frequent changes in the O&G price of oil, political turmoil or policy changes (Ahmad et al., 2016). These factors are no doubt, causing variations in the demand and supply of O&G and consequently, there is an effect on the entire supply chain of oil.

In Pakistan, the main sources of energy are a mix of oil, gas, LPG, and coal. 80% of the country's energy needs are met from O&G while 16% of the crude oil demands are fulfilled through the country's own resources. Pakistan's economy is highly dependent on the import of petroleum products and considered one of the utmost gas dependent economies of the world. 49% of the petroleum products are consumed by the transport sector, 42% by power generation and 5% by industrial sectors. The scarcity of gas resources in the country has also increased. Pakistan's available gas reserves are 27.8 Trillion: In short, Consumption of energy has grown to 39.8million tons of oil equivalents in 2014 as compared to 17 million tons in 1991. This reflects a 3.6 percent annual compound growth rate of 3.6 percent (Wasti, 2015). Principal energy supplies are increased to 50.9 million tons of oil equivalent during July-March 2015, showing a growth rate of 4.4 percent. To meet the demand of the country, currently, fifteen O&G producing companies and eight refineries are functioning. The main producing companies are Oil & Gas Development Company Limited (OGDCL) a national O&G Company having the highest share of 50%, MOL Hungarian O&G Company (MOL) contributed 19.98%, United Energy Pakistan (UEP) 15.5% and Pakistan Petroleum Limited (PPL) 7.4% during 2013-14. Refineries have the capacity to refine 18.79 million tones as shown in Table 1.

Table 1: O&G Production and Refinery Capacity in Pakistan

O&G Production				Oil Refineries in Pakistan	Capacity Millions Tons per year
Sr. #	Company	Gas	Oil		
1	OGDCL	1,171	42,969	Pak-Arab Refinery Limited (PARCO)	4.5
2	PPL	648	6,420		
3	MPCL	593	642	National Refinery Limited (NRL)	2.71
4	Eni	489	353		
5	BHP	286	1,393	Pakistan Refinery Limited (PRL)	2.1
6	MOL	287	17,293		
7	OMV	310	46	Attock Refinery Limited (ARL)	1.92
8	UEP	206	13,464		
9	PEL	20	-	Byco Oil Pakistan Limited (Byco-1)	1.74
10	Dewan	18	136		
11	POL	15	1,943	Byco Petroleum Pakistan Limited (Byco - II)	5.45
12	Hycarbex	11	-		
13	POGC	10	-	ENAR Petrotech Refining Facility (I&II)	0.33
14	OMV	18	1,259		
15	OPL	9	616	Total	18.75
	Total	4,091	86,534		

(Source: Ministry of Petroleum and Natural Resources Monitoring and Evaluation Unit, Government of Pakistan).

Owing to the high demand for O&G in the country (see Table 1), it is a must for the industry to look for ways to improve their current operational practices and remove bottlenecks in the process of

the supply chain. This requires in the first place to determine the level to which the O&G industry of Pakistan is following best practices.

Supply chain management is the integration of supply chain partners in such a manner so that the right product is manufactured and distributed to the right locations, in time and with minimized operational costs (Simchi-Levi et al., 2008). In order to accomplish this task; Information, material, labor, financial assets, capital and other resources have to be properly managed. Therefore, the partners in the chain must consider the costs versus benefits of every decision it formulates along the supply chain (Chima, 2007).

In addition to the cost-benefit analysis, supply chain partners must also focus on growing complex issues regarding coordination and communication to establish successful relationships with manufacturing, storage, delivery, contracting and customer services (Dowty & Wallace, 2010). Primarily the supply chain in oil is integrated vertically, with a push system perspective (Gainsborough, 2005; Hull, 2002; Stabell, 2001). Demand-pull come into view only at setting up activities for the deliverance of the products to the consumers.

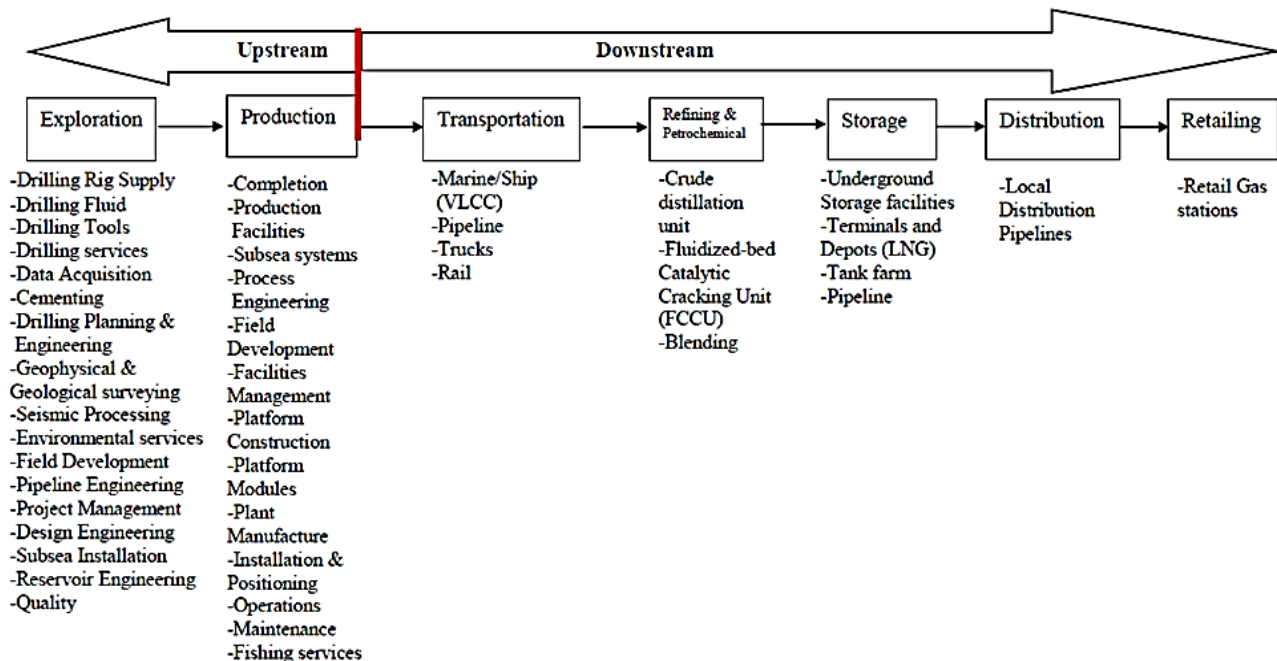


Figure 1: Typical O&G Value Stream

Three main stages are involved in the extraction of O&G; exploration, construction of the field, and production (Hallwood, 1991). The main activities can then be categorized as upstream and downstream activities. Figure 1 categorizes the activities of extraction and production of the raw O&G which are part of upstream section of the industry whilst all other activities such as processing (refining and petrochemicals), logistics and delivery service, storage and distribution to deliver the product to the consumer is part of the downstream section of the supply chain.

Despite the significance of SCM, the petroleum industry has nervousness about teamwork and information sharing (Hussain et al., 2006). The logistics affair is only one of many areas, which will have an impact on the performance of the supply chain in the O&G industry

Overall, a collaborative approach to data standards, information exchange, total process tracking, and automation are considered as the prerequisite for more seamless operations in the O&G industry (Kukareko, 2013). Supply chain optimization is the main prospect for the majority of companies to considerably decrease cost and improve performance. Gainsborough (2005) emphasizes that seeking

opportunities for optimization of the O&G supply chain is highly prioritized in the industry due to the great potential for cost savings. Optimization endeavors to reach the most efficient, optimal way to control the supply chain so as to satisfy end users' requirements with the lowest possible cost.

3. METHODOLOGY

3.1 SC MATURITY ASSESSMENT TEST (SCMAT)

It is important to address to which degree Pakistan's O&G industry manages the issues of operation strategy; hence, the proposed model should include best practices that consider the SCM issues. SCMAT, developed by Netland et al. (2007), is an appropriate model for the purpose. It is appropriate because this maturity model contains detailed, tested and verified maturity measures with reference to SC and operations management (Netland & Alfnes, 2011). SCMAT is based on the belief that an evaluation tool needs detection of the best practices in the areas under observation. Therefore, the core of SCMAT is 48 stated best practices, which are appraised regarding maturity. Supply Chain Council defines best practices as "existing, planned and repeatable practices that have had proven and positive impact on supply chain performance". In addition, SCMAT is also compatible with Chima (2007), strategies, which are useful for improving the operational performance of the supply chain, this strategy focus on customer service segmentation, logistics customization, market-based situational planning, strategic partnership, etc.

The level of maturity for different operations is measured using maturity scales and nearly every maturity model has some sort of maturity stage. The maturity means the impression of improvement from some preliminary state to a more advanced state. Thus, in the case of a company, it passes through several transitional maturity phases on the way to maturity. Maturity models depict a series of maturity levels with objectives and best practices to accomplish in order to advance to the next successive maturity level (Looy et al., 2011).

It is noteworthy that most of the best practices in SCMAT are applicable to the O&G industry. However, the industry relies more on asset management and reliability than on customization, velocity, flexibility (Jacoby, 2012). In this study, we will not be making any adjustments when applying SCMAT in the O&G industry in Pakistan. However, when interpreting the results of the test, one must be aware of the principles established in Jacoby (2012) study.

3.2 APPLICATION OF SCMAT TO O&G SUPPLY CHAIN IN PAKISTAN

This study focuses on the key actors of service and supply companies from the upstream and downstream sides of the Oil & Gas industry of Pakistan. Non-Probability sampling was chosen, i.e. a purposive sampling, selecting specifically or typical interesting cases.

Although supply chain management is a recognized fact, however, in Pakistan, it is practiced in a limited scope. During the sample selection and data collection process, it was ensured, that the companies were involved formally in the field of SCM and already appointed people in pertinent positions, answers from respondents who don't have knowledge cannot be relied on, which rise the bias (even or random) (Forza, 2002). The companies, with no managerial or executive positions within the field of the supply chain, are excluded from this study, as they cannot provide clear evaluation, based on the scope of study that is SCM.

The unit of analysis in this study is the O&G companies in Pakistan. However, respondent classification is essential to verify who will give the information. The 13 respondents who responded to the questionnaire are key informants (Table 2). The reason to choose these respondents is that “they are supposed to be knowledgeable about the issues which are being researched in this study and the selected key respondents are also willing to communicate” (Kumar et al., 1993).

These key informants are chosen to have the top management (senior managers/general managers) positions in the investigated companies and also have interaction with the SCM and logistics operation. The reason to target these positions is that their response is to be considered as the company’s response and that these roles have the knowledge and prerequisite to answer the questionnaire regarding the use of best practices.

Table 2: Sample profile of companies

Company Activity	Number of Responses
Upstream	6
DownStream	5
Services/Engineering	2
Total	13

In order to eliminate the single respondent bias on the circulation of the questionnaire, it was conversed with the key respondents to respond to the questionnaire after feedback from the supply chain or logistics functions within the company. With this in mind, this approach relies heavily on the key informant's view of SCM best practices, and to what degree they distinguish that their companies are using these best practices. With the respondents holding adequately important hierarchical positions and with the anonymity of the responses, the definition of a key informant is supported (Seidler, 1974).

3.3 NATURE OF QUESTIONNAIRE

A self-assessment survey instrument was adopted from Torbjørn H Netland et al. (2007) using a 5-item Likert scale measuring the frequency of the best practices by asking the respondent the following question: “To which extent does our supply chain use best practice stated?” The alternatives ranged from 1 = “Never or do not exist”, 2 = “Sometimes or to some extent”, 3 = “Frequently or partly exist”, 4 = “Mostly or often exist”, and up to 5 = “Always or definitely exist”. This maturity scale is the same for all the best practices that are to be appraised in the test. The respondents were emailed the survey. The authors emphasized the simplicity characteristics as stated by Fraser et al. (2002). The simplicity characteristics are vital for this study due to time and resource restrictions. 17 companies were contacted to take part in the study and an aggregate of 13 questionnaires was acknowledged, which becomes a response rate of 76%. It is imperative to have a response rate higher than 50% within operations management (Flynn et al., 2010). 13 out of the 17 companies from upstream, downstream and services companies responded, and they found no confusion in filling the questionnaire. It is valuable to make sure of the reliability of the available sample. Even if the number of companies is quite small, but the study should meet the standard of good trustworthiness of small samples according to the criteria presented by Forza (2002).

4. RESULTS AND DISCUSSIONS

For this study, the data analysis is to examine and define the maturity level of each company, i.e.

total maturity points. The maturity of each company's SCM for each maturity decision area is demonstrated in the following Table 3. The sample has a mean value of 176.77, demonstrating INTEGRATED maturity, with a median of 188, also indicating that maturity is INTEGRATED, and a standard deviation of 33.18. The maturity of specific decision areas differs throughout the company and between companies. That is a company that scores lower on total maturity points than another company can score higher on a specific maturity variable.

The highest score achieved among these companies is 207. But none of the companies scored up to the extended level i.e. 212 or greater. Keeping in view to superlative performance i.e. maturity level 5 (extended), within each decision area. Organization (overall score 3.88) that has the highest maturity score in the overall sample of the O&G companies of Pakistan. On the other hand, the decision areas Information, Resources and Materials have the lowest overall score relative to world-class performance within those decision areas.

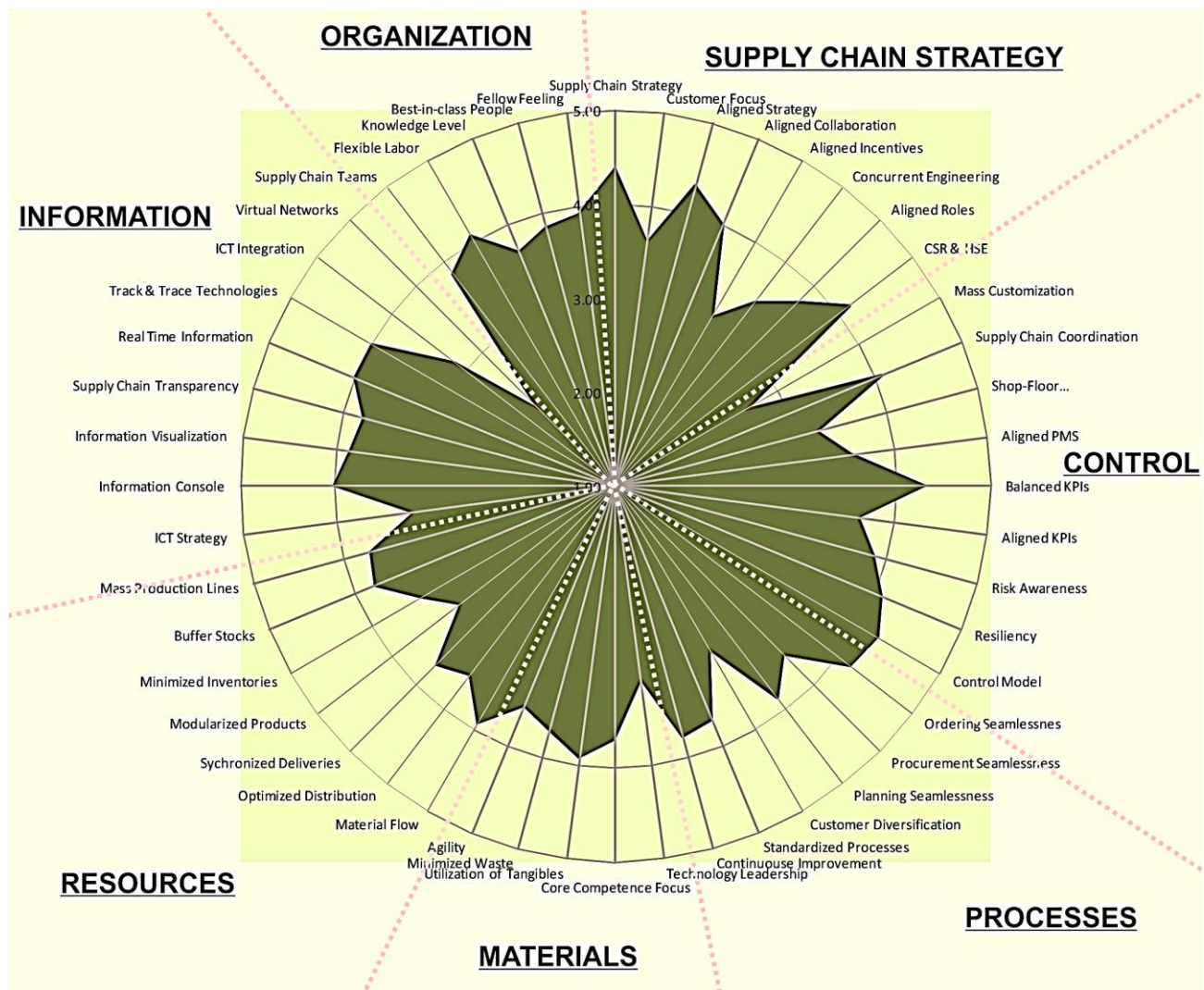


Figure 2: A radar diagram from SCMAT outcomes.

The radar chart in Figure presents the 48 stated best practices and their mean value maturity scores for the O&G industry of Pakistan, within seven object classifications. Using this chart, the participating companies can do a cross-comparison between their supply chain maturity and the maturity of the industry. The results can also be useful to mark areas that need improvement in order to line up the strategy with capabilities, and as a result to raise the level of maturity. From the radar chart, there are thirteen best practices that have an overall industry maturity score over 4.

The results of the top and bottom performing companies in Figure 3, their best practices score per decision area compared. It is obvious that the top-performing company is using much more “best practices”. The decision area Organization is the only one that is close to the same score.

During drilling operations, technical hurdles and downtime occur. In such circumstances, the suppliers responsible for may be penalized, but the cost to the oil companies is far greater in terms of lost progress. Partners in the supply chain should share costs, risks and benefits when the goal is to raise the performance of the supply chain, i.e. incentives are aligned. This is supported by our study in which the *Aligned Incentives* achieved a mean score of 3.08 and a linked maturity.

Companies need to have metrics that classify how business strategy is met, and what is relevant to their customers. Pakistan's O&G industry appears to only partially use KPIs which are regularly calculated and reported to the whole supply chain. Thus, the best practice aligned KPIs end up with an overall score of 3.62. The O&G industry of Pakistan uses performance management systems (PMS) to extend to transform supply chain strategy into goals, plans, metrics, and tasks designed for every entity (group and/or individual) in the supply chain. The best practice *Mass customization* scored a mean value of 2.62 (defined level), which is assembling and promoting the system, which consolidates the adaptability and personalization of specially designed items, with the low unit costs connected with large scale manufacturing.

The research revealed that the O&G industry of Pakistan struggles with process standardization and continuous improvement across the supply chain. This is evident with the overall score of 3.67 in the best practice of continuous and incremental improvement. However, the results of this study reveal that most companies still have a way to go before processes are standardized between the supply chain partners, i.e. defined, updated and documented.

Table 3: Distribution by the company for SCM maturity variables

Company	Variables of Maturity (pts.)							Maturity Points	Maturity Level
	Strategy	Control	Processes	Resources	Materials	Information	Organization		
OGDCL	31	34	19	17	29	24	15	169	Linked
MOL	34	36	22	20	27	27	22	188	Integrated
PPL	37	43	26	20	25	30	23	204	Integrated
POL	12	16	11	11	11	8	11	80	Defined
OPL	35	31	25	19	30	29	18	187	Integrated
DEWAN	33	36	25	19	28	30	23	194	Integrated
APL	32	32	21	22	22	21	20	170	Linked
PSO	26	32	20	16	25	32	19	170	Linked
SNGPL	20	27	16	12	25	31	19	150h	Linked
PARCO	36	36	25	19	27	30	20	193	Integrated
ARL	35	41	27	20	26	36	22	207	Integrated
SCHLUMBERGER	34	36	24	19	27	32	19	191	Integrated
LMKR	35	36	25	19	24	35	21	195	Integrated
Mean Value	30.77	33.54	22	17.92	25.08	28.08	19.38	176.77	Integrated
Standard Deviation	7.29	6.69	4.58	3.2	4.73	7.26	3.36	33.18	
Median Value	34	36	24	19	26	30	20	188	Integrated

The results clearly demonstrate that the industry is still lagging in ICT strategy and ICT integration, a decision area of information. The mean score of the industry is slightly above the 3 (maturity level linked), and for the virtual networks, the mean score of the industry is slightly above 2 (maturity level defined). Although such systems exist which provide equivalent access to supply chain partners for forecasting, the status of inventory, sales data points, but the industry does not seem to have understood the potential performance outcome of implementing such systems. However,

there should be a cultural change within the organization to support sophisticated information technology which eases collaboration.

With higher profit margins, asset risk management (risk, utilization, and productivity) is an important part of the supply chain (Jacoby, 2012). This study reveals that the O&G industry of Pakistan has high utilization of machines, transportation vehicles, inventory and facilities (i.e. a score of 3.92 on the best practice utilization of tangibles). Still, improvement is necessary to reach integrated maturity, and it will be important in the future for a reduction in operating costs.

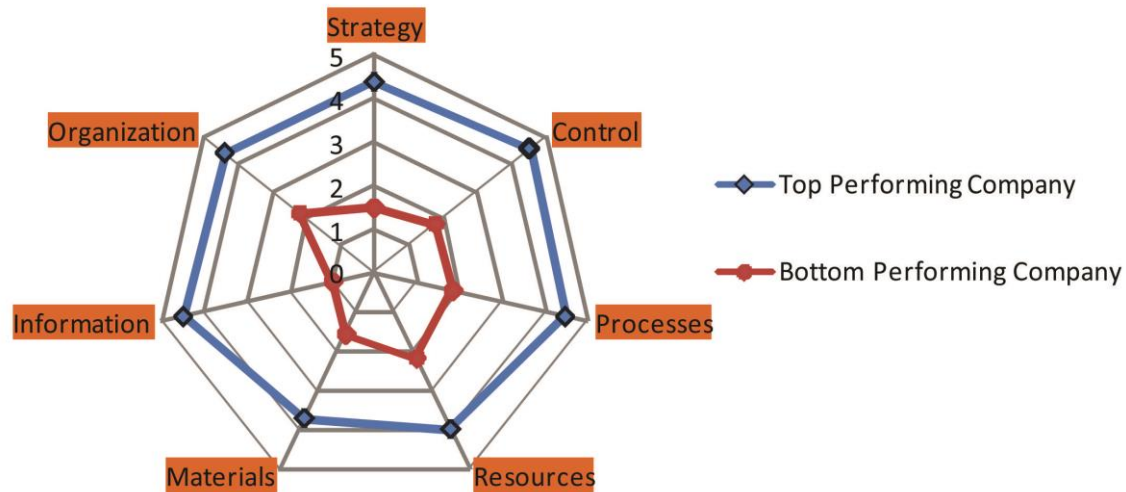


Figure 3: Comparison of the use of best practices in different decision areas

The results show that the best practice of *mass production lines* is in use within the participating companies (score 3.69), near to the integrated maturity level. The companies are deciding on whether to have supply chains that are make-to-order, make-to-stock, or make-to-engineering (includes the design process) for specific products, instead of having one supply chain which might not be suited for all products and services. Jacoby (2012) contends that upstream activities fall into make to plan and make to stock supply chains where the material flow is continuous. On the other hand, the oil field service companies seem to be sensitive regarding significant rig downtime or longer production times, and hence, increase in operational cost that could delay deliveries to oil operators but the industry almost reaches to integrated maturity (score 3.77) in the best practice concerning buffer stocks which shows level of importance on the part of oil field service companies.

The industry reaches a score of 3.69 on the best practice *synchronized deliveries*, which consider synchronization of delivery of products and/or complementary services from different actors in the supply chain to fulfill customer needs. The results of this study do not expect to fully concur on this as the Pakistani Oil & Gas industry more than frequently decides the degree of collaboration keeping in view different factors like the importance of product, availability and the degree of customization.

Areas that are within the maturity stage 1-2 and 4-5 should be the primary focus of the companies. Because the areas with a low level of maturity are well-thought-out to have remarkable improvement potential and areas with a high level of maturity can create further competitive advantage by being best in class. The focus should also be on the strategic decision areas that are most important for the O&G industry. In the context of the O&G industry of Pakistan, the results proved that there is a lack of IC strategy in all processes, ICT systems are not integrated and standardized to

facilitate connectivity across supply chain players.

SCMAT does not provide answers to why a company is at a certain maturity level, it only poses questions that need to be examined further. Hence, there is a need to appraise and have a strategic discussion around the obtained results from the test to establish projects for supply chain improvement in line with business strategy.

5. CONCLUSION

This research appraised the maturity of the supply chain of the O&G sector of Pakistan in a comprehensive and structured way. From the study, it was observed that O&G SCM is complex and challenging, and the industry in Pakistan is still in the development stage for effectively managing its supply chains. To know how capable the industry's supply chain is to meet the challenges, the SCMAT maturity model was used to assess the current state of supply chain practices. The model relied on a Likert type questionnaire where qualitative data regarding supply chain best practices in seven decision area namely strategy, control, processes, materials, resources, information, and organization was chosen. From the collected data, maturity levels in individual decision areas and overall maturity of the supply chain were determined. Companies with a low level of maturity in any decision area have the potential to be improved and areas with high maturity levels can provide a competitive advantage to the company's supply chain. From the maturity points, it is evident no O&G company in Pakistan reached to the extended level that is level 5. However, the mean score indicates that the industry supply chain stands at the Integrated level, level 4.

To get the world-class "extended level", the supply chain managers should simplify their value streams and focus on areas that have the potential for improvement. The results of the maturity test are also useful to provide support to strategic operational activities.

The empirical basis of the research is narrow, but it meets the principles of good reliability and its results can be applied to analyze at what maturity level the O&G industry of Pakistan is standing in relation to supply chain and operations management best practices. The study does not consider complete Pakistan's O&G sector, but only companies having managerial and executive positions within logistics and supply chain. In future research, other companies which do not have logistics and supply chain positions should also be included. However, in that case, along with a questionnaire, face to face interviews should be emphasized to minimize the possibility of misinterpretation of the best practices.

Cross-industry benchmarking is a very useful exercise to improve business processes and competitiveness. In future research, it would be worthwhile for seeking industry that is more mature than O&G Industry, for making a comparison of how mature is that industry from Oil & Gas industry and to which level O&G industry can learn from the more matured industry.

4. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

5. REFERENCES

Aminuddin, U., & Mazari, S. M. (2004). Opportunities in the Development of the Oil & Gas Sector in South Asian Region: Institute of Strategic Studies.

- Battista, C., & Schiraldi, M. M. (2013). The Logistic Maturity Model: Application to a Fashion Company. *International Journal of Engineering Business Management*, 5, 29. DOI: 10.5772/56838
- Bowersox, D. J., & Daugherty, P. J. (1995). Logistics paradigms: the impact of information technology. *Journal of Business Logistics*, 16(1), 65.
- Chima, C. M. (2007). Supply-chain management issues in the oil and gas industry. *Journal of Business & Economics Research (JBER)*, 5(6).
- Crosby, P. B. (1980). *Quality is free: The art of making quality certain*: Signet.
- Dowty, R. A., & Wallace, W. A. (2010). Implications of organizational culture for supply chain disruption and restoration. *International Journal of Production Economics*, 126(1), 57-65.
- Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: a contingency and configuration approach. *Journal of operations management*, 28(1), 58-71.
- Forza, C. (2002). Survey research in operations management: a process-based perspective. *International journal of operations & production management*, 22(2), 152-194.
- Fraser, P., Moultrie, J., & Gregory, M. (2002). The use of maturity models/grids as a tool in assessing product development capability. Paper presented at the IEEE international engineering management conference.
- Gainsborough, M. (2005). RFP4-Downstream Supply Chain Optimization. Paper presented at the 18th World Petroleum Congress.
- Giachetti, R. E., & Garcia-Reyes, H. (2010). A Maturity Model to Assess and Improve Supply Chain Operations. Paper presented at the IIE Annual Conference. Proceedings.
- Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International journal of operations & production management*, 21(1/2), 71-87.
- Hallwood, C. P. (1991). On Choosing Organizational-Arrangements: The Example of Offshore Oil Gathering1. *Scottish Journal of Political Economy*, 38(3), 227-241.
- Hilmola, O.-P. (2011). Logistics sector development potential of world's oil exporters. *International Journal of Energy Sector Management*, 5(2), 256-270.
- Hull, B. (2002). A structure for supply-chain information flows and its application to the Alaskan crude oil supply chain. *Logistics Information Management*, 15(1), 8-23.
- Hussain, R., Assavapokee, T., & Khumawala, B. (2006). Supply chain management in the petroleum industry: challenges and opportunities. *International Journal of Global Logistics & Supply Chain Management*, 1(2), 90-97.
- Jacoby, D. (2012). *Optimal Supply Chain Management in Oil, Gas, and Power Generation*: PennWell Corporation.
- Kohlegger, M., Maier, R., & Thalmann, S. (2009). Understanding maturity models. Results of a structured content analysis: na.
- Kukareko, K. (2013). Virtual warehousing in offshore oil and gas platforms' supply chain. *Høgskolen i Molde-Vitenskapelig høgskole i logistikk*.
- Kumar, N., Stern, L. W., & Anderson, J. C. (1993). Conducting interorganizational research using key informants. *Academy of management journal*, 36(6), 1633-1651.
- Lockamy III, A., & McCormack, K. (2004). The development of a supply chain management process maturity model using the concepts of business process orientation. *Supply Chain Management: An International Journal*, 9(4), 272-278.
- Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). DEFINING SUPPLY CHAIN MANAGEMENT. *Journal of Business Logistics*, 22(2), 1-25. doi: 10.1002/j.2158-1592.2001.tb00001.x
- Netland, T. H., & Alfnes, E. (2011). Proposing a quick best practice maturity test for supply chain operations. *Measuring Business Excellence*, 15(1), 66-76.

- Netland, T. H., Alfnes, E., & Fauske, H. (2007). How mature is your supply chain?-A supply chain maturity assessment test. Paper presented at the Proceedings of the 14th International EurOMA Conference Managing Operations in an Expanding Europe.
- Seidler, J. (1974). On using informants: A technique for collecting quantitative data and controlling measurement error in organization analysis. *American Sociological Review*.
- Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., & Shankar, R. (2008). *Designing and managing the supply chain: concepts, strategies and case studies*: Tata McGraw-Hill Education.
- Simon, A. T., Serio, L. C. D., Pires, S. R. I., & Martins, G. S. (2015). Evaluating supply chain management: A methodology based on a theoretical model. *Revista de Administração Contemporânea*, 19(1), 26-44.
- Stabell, C. (2001). New models for value creation and competitive advantage in the petroleum industry.
- Van Looy, A., De Backer, M., & Poels, G. (2011). Defining business process maturity. A journey towards excellence. *Total Quality Management & Business Excellence*, 22(11), 1119-1137.
- Wan Ahmad, W. N. K., de Brito, M. P., & Tavasszy, L. A. (2016). Sustainable supply chain management in the oil and gas industry: A review of corporate sustainability reporting practices. *Benchmarking: An International Journal*, 23(6), 1423-1444. doi: doi:10.1108/BIJ-08-2013-0088
- Wasti, S. (2015). *Economic survey of Pakistan 2014-15*. Islamabad: Government of Pakistan.
- Wendler, R. (2012). The maturity of maturity model research: A systematic mapping study. *Information and software technology*, 54(12), 1317-1339.



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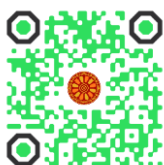
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SUBSTANTIATION OF ELECTRIC FIELD IMPACT USE ON THE PROCESS OF MOISTURE SEPARATION FROM POROUS WASTE STRUCTURES

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ABSTRACT

During the study, information was collected and analyzed on the possibility of an electroosmotic device production - the converter of colloidal polydisperse systems into capillary-porous by electroosmotic dehydration in order to reduce the residual moisture of sewage sludge and pulp and paper industry wastes. Exponents were taken as the models expressing the mass of waste, as the function of drying time and electric current. According to the obtained determination coefficients, they concluded that the models corresponded to the initial experimental data, the use of exponential models were justified for further optimization of colloidal polydisperse system conversion into capillary porous ones.

Disciplinary: Waste Engineering.

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1. INTRODUCTION

The purpose of the study is to collect and analyze information on the possibility of an electroosmotic device production - the converter of colloidal polydisperse systems into capillary-porous systems by electroosmotic dehydration in order to reduce the residual moisture of sewage sludge and pulp and paper industry wastes. The analysis of technological innovation production possibility increase in the field of environmental safety of industrial enterprise improvement, the study of insulation material production possibility using dehydrated waste as a raw material (The concept of long-term socio-economic development of the Russian Federation for the period until 2020, 2009). The relevance of the study is confirmed by the urgent need of modern industrial enterprises in innovative approaches to the issue of environmental friendliness of production. In addition, high-quality indicators of imported products create a competitive environment for developing domestic enterprises. The solution to this situation may be an active

introduction of modern technologies into domestic production.

During various technological processes, a significant amount of wet waste and residues is generated. At the enterprises of the pulp and paper industry (PPI) a large amount of waste is formed. Waste is a large-tonnage, environmentally friendly waste of wastewater treatment plants of the paper industry, which is a composite material containing environmentally friendly components of the raw mix for paper production (The list of priority areas for the development of science, technology, and machinery of the Russian Federation, 2011).

2. METHODOLOGY

Wet waste is a colloidal polydisperse system. However, with decreasing humidity, wet waste takes on the typical properties of capillary-porous materials. For further energy-efficient disposal of wet waste, they considered the possibility of a model production for colloidal polydisperse system conversion into capillary-porous systems, necessary for pressing and electrodynamic separation of moisture from waste structures.

The essence of the model for colloidal polydisperse system conversion into capillary-porous ones for the purpose of further electroosmotic dehydration is to achieve the maximum energy-efficient effect of the dehydration process. Figure 1 schematically shows an optimized device of an electroosmotic installation for debugging a technological process of waste paper production dehydration, where ① is a housing made of insulating material; ② - movable electrode; ③ - fixed electrode with perforation; ④ - top cover with thread for screw ⑤, which creates (regulates) the initial pressure (by torque wrench) for waste compression ⑥. An electric voltage (electric current) is supplied to the electrodes ② and ③ through the wires ⑦ and ⑧, which provides the necessary electric field strength, which causes the effects of particle velocity variation, ⑨ - perforation in the housing around the entire perimeter, which ensures additional convection dehydration after completion of the electroosmosis process during the electrode ② lifting, ⑩ - an external regulator of the housing inclination angle, providing convection dehydration of the lower layers of the mass after completion of the electroosmosis process, ⑪ - insulation sump for separated moisture collection.

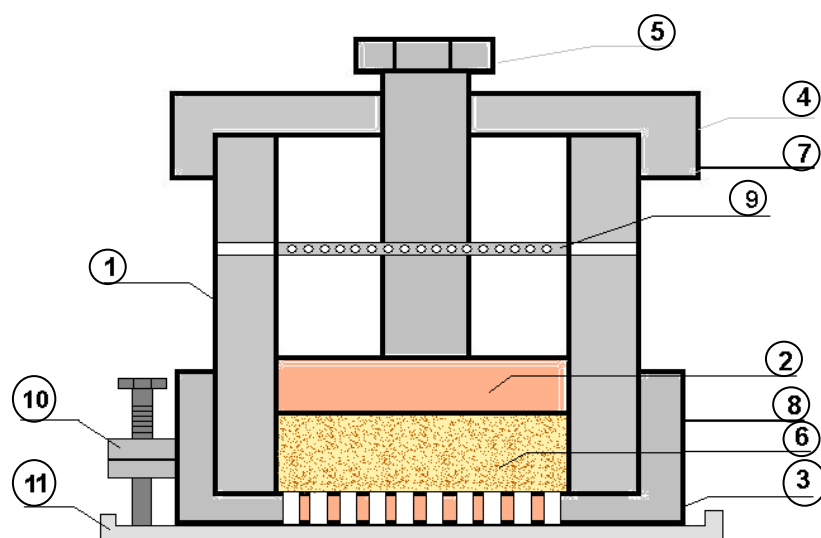


Figure 1: Laboratory electroosmotic device.

The abovementioned technical solution allows to carry out most energy-efficient electroosmotic dehydration process as compared to the state of technology, since by varying direct and alternating current with an output voltage of, for example, 8, 16, 24 V and an output current of a voltage source of

20 A, the effect of Joule heat generation is achieved (the data on thermal energy released during dehydration is given in Table 1), which promotes dehydration without additional energy costs (Pegat, 2009).

Table 1: The energy released in waste during the action of osmosis

t^*, h	0	0.08	0.16	0.25	0.33	0.42	
$W_{ob}^w W$	0	3.919	6.96223	9.5808	11.3588	12.888	
t^*, q	0.5	0.58	0.66	0.75	0.83	0.91	1
$W_{ob}^w W$	13.9274	14.7340	15.360	15.8993	16.265	16.5494	16.7939

Thus, the technical solution contributes to the additional separation of moisture under the action of gravity and partial convection drying, thanks to the perforated cathode and the device casing.

To increase water loss and improve the energy efficiency of the system, you can change the structure of the waste solid phase. This seems possible to achieve in several ways: by coagulating the waste with various chemicals, flocculation, or the introduction of certain filler materials, thermal conditioning (a sharp change in temperature - freezing or thawing), as well as by magnetic or electromagnetic processing. The result of these methods is a significant enlargement of waste particles, and the average surface area of the dispersed phase and dispersion medium decrease. Thus, the average surface energy decreases and the bonding forces of moisture with solid particles are weakened significantly. The redistribution of types (forms) of moisture bonding is actively carried out, while the content of "free water" increases due to the total amount of "bound" decrease. Moreover, all the above methods are quite expensive (Dudyshev et al., 2006; Rasouli et al., 2019; Santana et al., 2017).

The research results show that a significant amount of liquid can be removed from the waste volume by the electroosmosis method without resorting to the use of coagulants and at the same time the energy consumption can be less than during thermal drying use. They determined after a series of experiments, that the method of electroosmosis removes moisture from wet waste quite effectively.

According to the analysis, the electrokinetic phenomenon of moisture transfer through the pore space of capillary-porous media, caused by an external electric field superimposed on the diaphragm, was one of the first observed by Professor F.F. Reis, which he called "water-driving power." Subsequently, this phenomenon was called "electroosmosis", which means the movement of a fluid relative to the solid skeleton of a porous material under the influence of an electric field in the direction determined by the sign of the electrokinetic potential (Kholudeneva et al., 2016; Rahideh & Mazloun, 2019). When they implement the process of electroosmosis, the difference in phase charges leads to the movement of mobile counterions in a constant electric field together with the liquid phase to the corresponding pole of the current source. The electroosmotic transfer of fluid through the pore space of a capillary-porous body is determined by the electrokinetic potential and the structure of the double electric layer at the phase interface

The linear electroosmotic velocity of the fluid V_l is determined by

$$V_l = V_s + \frac{I\xi\xi}{4\pi^2\eta\chi r^2} \quad (1),$$

and volumetric electroosmotic fluid velocity V_o will be

$$V_o = \frac{I\xi\zeta}{4\pi\eta\chi}, \quad (2),$$

where

V_g – hydrostatic speed;

I – current strength;

ξ – dielectric conductivity;

χ – the electrical conductivity of the liquid;

η – liquid viscosity;

r – capillary radius;

ζ – electrokinetic potential (Kholudeneva, 2016).

The earliest known model of the double electric layer structure, which made it possible to explain not only the fact of electrokinetic phenomenon existence but also to quantify the value of the capacitance of the double electric layer, was proposed by Helmholtz (Kholudeneva, 2016; Hosseinzadeh et al., 2019).

When they apply technological innovation in the form of dehydration of paper production wastes, the final result is achieved, which is not only the production of unique products - insulation but also the achievement of environmental and social effect: more than 2000 m³ of waste does not enter the soil (the data only for Penza paper factories with average power indicators), thus, the negative impact on the human body caused by rotting and decomposition of waste is reduced (Kholudeneva & Ryzhakov, 2016).

The results of experiments on the study of electroosmosis, identified on the developed installation, are presented in Table 2, reflect the process of mass reduction m_j (Fig. 2) and the process of current reduction i_j (Figure 3).

Table 2: Experimental data on the study of electroosmosis.

t_j	0	0.16	0.33	0.5	0.66	0.83	1
m_j	70	48	38	35	32	29	27
i_j	2.5	1.63	1.21	0.8	0.53	0.31	0.09

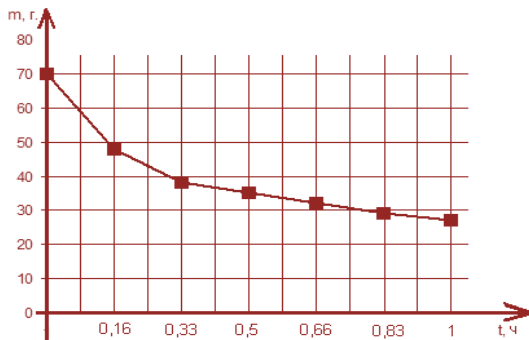


Figure 2: Experimental graph of weight loss during electroosmotic dehydration of waste.

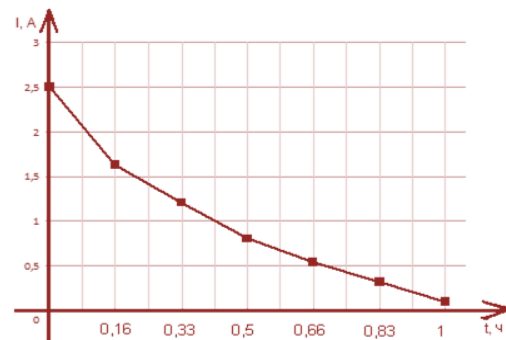


Figure 3: Experimental graph of current decrease during dehydration (drying)

From these data it follows that one can take the following exponents as the models expressing the mass of the waste, as the function of drying time and the value of electric current (under certain initial

conditions): to change the mass of waste

$$m(t_j) = m_0 \cdot e^{-\frac{t_j}{\tau_m}}, \quad (3)$$

where m_0 - the initial value of the waste mass loaded into the device,

τ_m - the time constant of waste mass reduction

t_j - the time point of mass control $t_j \in \{0; t_1; \dots; t_m\}$,

and for the current change

$$i(t_j) = I_0 \cdot e^{-\frac{t_j}{\tau_i}} \quad (4),$$

where I_0 - the initial value of the electric current flowing through the waste,

τ_i - the time constant of the current reduction process at $U = const$ on the plates (electrodes) of the device.

As observations have shown, the waste dries to a certain extent by convective means during restart and in the process of the electroosmosis effect control. This loss was excluded in the processing of experimental data and in the further study of electroosmosis. This allowed us to assess the relationship between the electric current flowing through the waste and the decrease of its mass caused by electroosmosis more accurately.

In order to avoid the influence of waste initial mass fluctuations, which occur when the unit is loaded, we pass from the subject scales of mass $m(t)$ and current $i(t)$ to universal $\delta_m(t)$ and $\delta_i(t)$, following the formulas:

$$\delta_m(t_j) = \frac{m_{oc}(t_j)}{m_o} = e^{-\frac{t}{\tau_m}} \quad (5),$$

$$\delta_i(t_j) = \frac{i_{oc}(t_j)}{I_o} = e^{-\frac{t}{\tau_i}} \quad (6)$$

The data of Table 3 is presented in units of universal scales.

Table 3. Experimental data on the study of electroosmosis in universal scales

j_u	0	0.16	0.33	0.5	0.66	0.83	1
$\delta_m(t_j)$	1	0.69	0.54	0.5	0.46	0.41	0.39
$\delta_i(t_j)$	1	0.65	0.48	0.32	0.12	0.09	0.03

The main parameters in the model (5) and (6) are time constants τ_m and τ_i . To evaluate them, we linearize the model by a logarithm

$$\ln \delta_m(t_j) \cdot \tau_m = -t_j \quad (7);$$

$$\ln \delta_i(t_j) \cdot \tau_i = -t_j \quad (8)$$

and use the well-known least-squares method (LSM) rules.

Then, taking into account (7) and (8), the sum of squares (S^2) for m and i can be written as

$$S_m^2 = \sum (t_j - \ln \delta_m(t_j) \cdot \tau_m)^2 \quad (9),$$

$$S_i^2 = \sum (t_j - \ln \delta_i(t_j) \cdot \tau_i)^2 \quad (10),$$

where $t_j, \delta_m(t_j), \delta_i(t_j)$ - the experiment data.

$$\frac{\partial S_m^2}{\partial \tau_m} = \sum_{j=0}^n [t_j + \ln \delta_m(t_j) \cdot \tau_m] \cdot \ln \delta_m(t_j) = 0 \quad (11),$$

$$\frac{\partial S_i^2}{\partial \tau_i} = \sum_{j=0}^n [t_j + \ln \tilde{\delta}_i(t_j) \cdot \tau_i] \cdot \ln \tilde{\delta}_i(t_j) = 0 \quad (12).$$

After simple transformations we get

$$\tau_m = \frac{\sum_{j=0}^n (t_j \cdot \ln \delta_m(t_j))}{\sum_{j=0}^n (\ln \delta_m(t_j))^2} \quad (13),$$

$$\tau_i = \frac{\sum_{j=0}^n (t_j \cdot \ln \delta_i(t_j))}{\sum_{j=0}^n (\ln \delta_i(t_j))^2} \quad (14).$$

According to the experiment results, it turns out that:

$$\tau_m^* = 0.856 \text{ h.}; \quad \tau_i^* = 0.323 \text{ h.}$$

Here we check the correspondence of the models to the initial experimental statistics by evaluation the determination coefficients.

$$n_{\tilde{\delta}_m} = \sqrt{1 - \frac{\sum_i (\delta_m(t_j) - \bar{\delta}_m(t_j))^2}{\sum_i (\delta_m(t_j) - \tilde{\delta}_m(t_j))^2}} \quad (15);$$

$$n_{\tilde{\delta}_i} = \sqrt{1 - \frac{\sum_i (\delta_i(t_j) - \bar{\delta}_i(t_j))^2}{\sum_i (\delta_i(t_j) - \tilde{\delta}_i(t_j))^2}} \quad (16);$$

$$n_{\tilde{\delta}_m} = 0.905; \quad n_{\tilde{\delta}_i} = 0.764.$$

According to the obtained determination coefficients, we can conclude that the models correspond to the initial experimental data.

From Figures (2) and (3), it follows that $m(t)$ and $i(t)$ are partially interconnected, and to a large extent have differences according to the calculation data (2.4 times). This is the evidence that another factor also affects the drying process of electroosmosis: it is likely that the effect of Joule heat accumulated in the waste makes its influence. This process is specific and requires additional studies, which will be carried out in a separate article.

It follows that the parameters of the models can vary. The latter will be implemented by varying the electric field on the device electrodes, but this fact is the detailing of the technological process implementation.

The results of individual experiments show that the electroosmosis drying mode and electrophoresis mode can be represented by exponents, but these exponents have different time constants.

It should be noted that the processes of electroosmosis and electrophoresis can take place in the experimental dosage of waste at the same time: with the residual volume (mass) of water and the technological dosage of the binder (liquid glass).

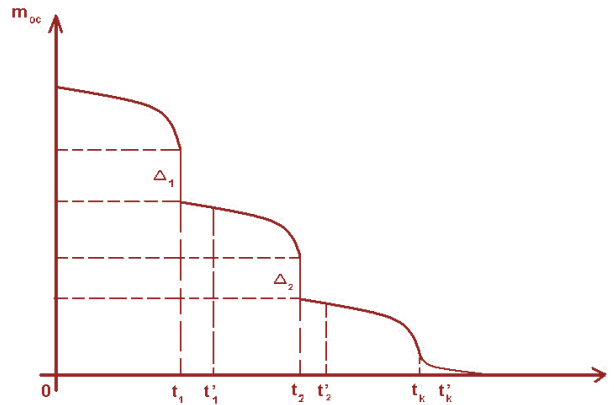


Figure 4: The results of experiments of waste drying with electroosmosis and electrophoresis, taking into account the loss of waste mass upon reboot

As indirect measurements have shown, the essence of the method is the following: $\Delta_1, \Delta_2, \dots$ - the “loss” of waste mass during the reboot in the process of the effect of electroosmosis control, i.e. in this case, the waste dries to a certain extent by convective means. This loss must be excluded from the study of electroosmosis. This procedure will make it possible to assess more accurately the correlation between the electric current flowing through the waste and the “loss” of its mass caused by electroosmosis.

After the conversion (deduction of mass loss $\Delta_1, \Delta_2, \dots$) the graph takes the following form:

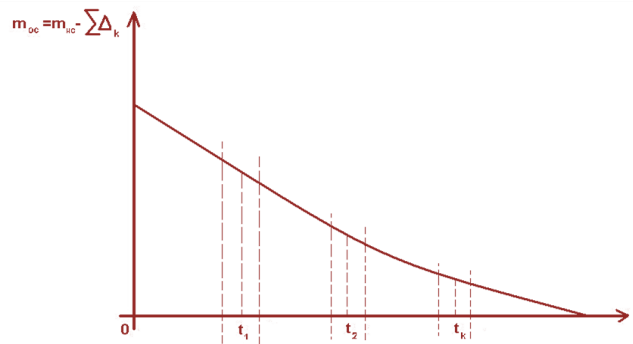


Figure 5: The results of waste drying experiments with electroosmosis and electrophoresis, taking into account the loss of waste mass during reboot after conversion.

$$\begin{aligned} m(\bar{t}_1) &= \frac{m(t_1) + m(t'_1)}{2} \\ m(\bar{t}_2) &= \frac{m(t_2) + m(t'_2)}{2} \\ &\dots \end{aligned} \quad (17).$$

According to (17), the model parameter is estimated. Let's take the exponent

$$m_{oc}(t) = m_{oc}^e \left(\frac{t}{\tau} \right) \quad \text{or} \quad \delta_{hoc}(t) = \frac{m_{oc}(t)}{m_{oc}(t_0)} = e^{-t/\tau} \quad \text{as its analytical transformation,}$$

where τ — unknown parameter.

Similar calculations should be repeated to evaluate the parameters of electroosmosis and electrophoresis current (in the latter case, it is necessary to evaluate the changes (increase or decrease) in the waste mass more accurately).

We get $\delta_{hoc}(t_i)$ and $i_{oc}(t_i)$. With this in mind, we find the estimates of the correlation functions.

$$r(\delta_{hoc}i_{oc}) = \frac{k(\delta_{hoc}i_{oc})}{\delta(\delta_{hoc})\delta(i_{oc})} = \frac{\sum \delta_{hoc}(t_i) - \frac{m_{hoc}(t_i)}{m_{hoc}(t_0)})(i_{oc}(t_i) - I_{oc}(t_i))}{\sqrt{\frac{1}{n-1} \sum_1^n \left[\delta_{hoc}(t_i) - \frac{m_{hoc}(t_i)}{m_{hoc}(t_0)} \right]^2} \cdot \sqrt{\frac{1}{n-1} \sum_1^n (i_{oc}(t_i) - I_{oc}(t_i))^2}} \quad (18).$$

Indirect measurement data and their analysis allow us to conclude that the process of electroosmosis and electrophoresis is manifested together. Their differentiation is difficult. Therefore, it is necessary to use phenomenological estimates (the time and time constant of experimental data censoring) based on experimental data [11]. In further experiments, we will measure the mass of waste (m_j) , corresponding to the time instant (t_j) , where j is the number of the temporary section $(j \in \{0, 1, 2, \dots, n\})$.

3. CONCLUSION

During the study, information was collected and analyzed on the possibility of electroosmotic device production - the converter of colloidal polydisperse systems into capillary-porous ones by electroosmotic dehydration in order to reduce the residual moisture of sewage sludge and pulp and paper industry wastes. An optimized installation model is proposed. The analysis of the possibility of technological innovation possibility increase in the field of environmental safety improvement of industrial enterprises. Exponents were taken as the models expressing the mass of waste, as the function of drying time and electric current value. According to the obtained determination coefficients, it was concluded that the models corresponded to the initial experimental data, the use of exponent models was justified for further optimization of colloidal polydisperse system conversion into capillary porous ones. The studied model of wet waste conversion into raw materials for building according to the obtained experimental data can significantly reduce the cost of utilization by enterprises and increase the environmental level of the pulp and paper industry.

4. REFERENCES

- Dudyshev, V. D., Semashko, V. D., Rokhmistrov, O. V., & Litikov, A. P. (2006). The device for moisture removal from porous materials. Patent of the Russian Federation RU 52735 U1. Publ. on 04/27/2006. Bull. Number 12.
- Kholudeneva, A. O. (2016). The research of the electroosmotic dehydration features of porous waste taking into account the osmosis physical model influence and the voltage values dynamics. *International Journal of Engineering Research* 11(19), 9842.
- Kholudeneva, A. O. (2016). Theoretical substantiation of automated information-measuring system introduction possibility to control the process of electroosmosis. Collection of scientific papers of the international scientific and practical conference "Information technologies in economic and technical problems" Penza: publishing house of PenzGSU. 197–200.
- Kholudeneva, A. O., Zhigalin, S. N., Ryzhakov, V. V., & Kupryashin V. A. (2016). Development of an ecologically clean technology for the recycling of paper production wastes. Collection of doc. from intern. scientific and practical. conf. "Youth and science: modernization and innovative development of the country." Part 3. - Penza: PSU, 248 - 250.
- Kholudeneva, A.O., & Ryzhakov, V. V. (2016). Processes of drying of moisture-containing materials: problems of ecology and choice of theoretical, schematic and experimental directions for their resolution. *International Journal of Applied Engineering*, India.
- Pegat, A. (2009). Fuzzy modeling and control. M.: Binom. *Knowledge laboratory*. 798 p.
- The concept of long-term socio-economic development of the Russian Federation for the period until 2020 (approved by the order N 1121-p of the Russian Federation Government on August 8, 2009).

Electronic fund of legal and scientific-technical documentation.
<http://docs.cntd.ru/document/902130343>

The list of priority areas for the development of science, technology and machinery of the Russian Federation (approved by Decree No. 899 from the President of the Russian Federation on July 7, 2011).
Electronic fund of legal and scientific and technical documentation.
<http://docs.cntd.ru/document/902287707>



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EFFICIENCY EVALUATION OF LISTED HOSPITAL COMPANIES IN THE CAPITAL MARKET: INTRODUCING A NEW HOSPITAL ADMINISTRATION AND FINANCING

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ABSTRACT

The capital market has an important role in the economy and stagnant money and capital flow through a company at a low cost. Because no studies have been published on listed hospital companies, researchers have sought to identify them, evaluate their efficiency and the determinate relationship between efficiency and profitability and liquidity ratios. This study was done in 2018. The statistical sample is 49 hospital companies listed on capital markets that were evaluated for the availability of financial data for 2013-2016. The DEA technique and regression in a panel data model has been used. The findings show that efficiency during the four years was 0.41, 0.77, 0.82 and 0.81 respectively, and there is a significant relationship between profitability and liquidity ratios and efficiency. In the world, hospitals are administrated as public companies in the capital market, in addition to other models. Some of these companies have one and some have more than one hospital in the capital market as active holdings. The increase and relatively good efficiency of hospital companies, given the direct correlation between efficiency and profitability and liquidity ratios, indicate the potential of companies to fulfill financial obligations and a positive evaluation of the companies' performance.

Disciplinary: Health Management, Management Sciences (Financial Management).

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1. INTRODUCTION

Different models of hospital administration and a variety of ownership and utilization have been implemented and evaluated in many countries. The World Bank defines four organizational models for the administration of public hospitals: budget hospital (administrative units affiliated to higher regional or national levels), Autonomous hospital (a budget hospital with more authority and responsibility to managers), corporate hospital (imitation of the private sector decision-making system at a public hospital) and private hospital (Preker & Harding, 2009). Other types of hospital administration include the private-public participation model (a long-term contract between the public and non-governmental sectors for the construction and administration of the hospital through the sharing of risks and benefits) and chain Hospitals or hospital holdings (A company which at least has controlling shares of subsidiaries and through their control, promote the value of company) (Abullhlaj & et al, 2015)

Among the models, the corporate model is a new topic in the hospital administration. A corporate model is formed for business purposes and its capital consists of equivalents or equal shares. Business Companies can be divided into special and joint-stock companies. The difference between them is that in the joint-stock company, the founders provide part of the company's capital through the sale of shares to people through the capital market. In the meantime, the importance of the capital market can be pointed out. This market plays a vital role in the economies of the countries and not only do the stagnant money and capital flow through the company, but they also act as an indicator of the economic prosperity of countries and provide access to a cheap source of finance. The capital market will enhance the excellence and growth of companies in a competitive and transparent environment and, while increasing their credibility in the community, it will contribute to growth (Securities and Exchange Organization, 2016). Also, admitting companies in the capital market will lead to an optimal allocation of capital, GDP growth and employment, wealth increase and economic well-being of the society (Shakibae & Golmohamadi, 2014; Barbosa, 2018; Shabestari & Malekzadeh, 2019).

One of the important issues in the capital market is efficiency. If the capital market is efficient, the price of securities is determined fairly, and the allocation of capital, which is the most important factor in the production and development of the economy, is performed optimally (Daniali & Mansouri, 2012). Since there has been no study on hospitals company in the capital market, and also with regard to the benefits of the capital market, this work has sought to identify listed hospital companies in the capital market and evaluate their efficiency in countries selected, upon reviewing their performance and introducing a new way of administration and financing for hospitals.

2. METHODOLOGY

The present study is descriptive and analytical, quantitative, inductive and applied.

2.1 HYPOTHESIS OF THE STUDY

In this research, a significant relationship between efficiency and profitability and liquidity ratios was calculated. The research hypotheses were formulated as follows.

- 1- Profitability ratios have a significant effect on efficiency in listed hospital companies.
- 2- The liquidity ratios have a significant effect on efficiency in listed hospital companies.

2.2 SAMPLE SELECTION

The statistical population of the study is hospital companies listed in the capital market.

According to a systematic review, 87 hospital companies were identified in the capital market. Among these, 49 companies were selected as a sample based on the availability of financial data. The selected companies had the following features:

- 1) At the time of the study, the company was in one of the security exchanges of the world.
- 2) The financial period ended in December.
- 3) At the time of the study, the company's activity or the financial year did not change.
- 4) Companies have been active in the field of hospitals or hospital operators.

2.3 DATA COLLECTION

The research was derived from the Yahoo Finance, Google Finance, Morningstar, Bloomberg, 4-Traders, Top foreign stocks, Money control, Ft Markets, and Aseanup databases, based on the actual stock market information, and consistent with the financial statements of hospitals. The research was done during 2013-2016.

2.3.1 TOOLS

In order to evaluate the efficiency of hospital companies, the nonparametric method of Data Envelopment Analysis (DEA) was used with the CCR input-axis model. Data Envelopment Analysis is a tool for measuring the relative efficiency of homogenous decision-making units that has multiple inputs and outputs. Since introducing this tool, many models have been introduced to measure performance, but all of these models are based on CCR and BCC models. For the relative evaluation of units, two fundamental characteristics must be determined: returns to scale and the nature of the pattern (input-output-axis). The CCR model evaluates the relative efficiency of units with constant returns to scale (each set of inputs produces the same number of outputs) and the BCC model evaluates the relative efficiency of units with variable returns relative to the scale (any number of inputs can produce the same number of outputs or less) (Dargahi & al, 2010) (Mohamadi & Dastyar, 2015) The choice of input and output nature is determined by the control of the organization on each input and output (Mehregan, 2011).

Since managers and decision-makers do not have much influence on outputs in the health sector, the selected model is input- axis model to evaluate the technical efficiency. However, they can have a great influence on the number and composition of input. Pham stated three reasons for using input-axis model in hospitals.

1. Demand for health services is growing and demand estimates for these services are difficult.
2. Managers have more control over resources (inputs) than services (outputs).
3. Hospitals are obligated to be accountable to the demands of public health, so costs need to be reduced and the resources need to be used economically. (Pham, 2013).

In order to measure the relative efficiency of hospital companies, the financial ratios were used as inputs and outputs, demonstrated in Table 1. To test the hypotheses, we employed a regression model in the form of compound data (to as compound data, which is a combination of cross-sectional data and time series). The F-lemmer test was used in the combination data method to choose between the panel and the pooling method. If a panel method was chosen, the Hausman test was used to select between Fixed Effects and Random Effects (Aflatoonan, 2018).

The statistical analysis was performed using DEA Solver Pro and EViews software.

Table 1: Variables of Data Envelopment Analysis Model (Abolhalaj, 2010)

Variable Type	Variable name	Definition	Formula
Input	Current Liabilities	Obligations expected to be settled during the normal operating period or within one year from the balance sheet date ¹	-
Input	Current Assets	Assets created during current activities and are expected to become cash in less one year ¹	-
Output	Quick Ratio	The ability of the company to pay off short-term debts using current assets with a rapid liquidity capability ²	$\frac{\text{Current Assets} - \text{Inventory}}{\text{Current liabilities}}$
Output	Current Ratio	Company's ability to pay off short-term debts using current assets ²	$\frac{\text{Current Assets}}{\text{Current liabilities}}$
Output	Return on Investment (ROI)	Profit from investment in the form of a percentage of the initial cost ²	$\frac{(\text{Net Return on Investment})}{\text{Cost of Investment}}$
Output	Return on Equity (ROE)	The company's efficiency in creating Net profit for Shareholders ²	$\frac{\text{Net profit}}{\text{shareholder's equity}}$
Output	Return on Assets (ROA)	The ability of management in the efficient use of assets ²	$\frac{\text{Net profit}}{\text{Total Asset}}$

3. FINDINGS OF THE STUDY

Hospital companies listed in the capital market were described in Table 2. The Company was described based on the names of the stock market, the year of admission to the stock market, the place of activity of the company and the number of hospitals in each company.

With input and output data, the efficiency of each company was measured using the CCR input-axis model for the four consecutive years 2013-2016, as shown in Table 4. According to the data obtained, the efficiency of 14 hospital companies in 2013, 13 companies in 2014, 15 companies in 2015 and 14 companies in 2016 was one (score of one represents the highest performance). The data shows that the average efficiency of hospital companies will be 0.77, 0.74, 0.82 and 81.8 in 2013, 2014, 2015 and 2016 respectively.

In the following, the research hypotheses were tested using a regression model in the form of panel data. In this regard, since the data are presented in a Time series (2016-2013), the reliability of the variables should be ensured to avoid false regression. The reliability of the variables means that the mean and variance of variables over time and the covariance of variables have been constant over the years. For reliability, Levine, Lin and Chv (LLC) tests were used. The hypotheses H0 and H1 for this test are:

H0: unit root exists and the variable is not reliable.

H1: unit root does not exist and the variable is reliable.

Table 2: Company Profile hospital in the capital market.

Row	Company	Stock market	Admission to stock exchange	Activity location	Number of hospitals
1	Community Health Systems, Inc.	New York and Nasdaq	1991	United States	152
2	HCA Healthcare, Inc.	New York and Berlin	1969	United States and England	177
3	Quorum Health Corporation	New York	1991	United States	31
4	Select Medical Holdings	New York	1997	United States	103
5	Tenet Healthcare Corporation	New York	1994	United States	97
6	Universal Health Services, Inc.	New York	1981	USA, UK, Puerto Rico and Virgin Islands	26
7	Life Point Health, Inc.	Nasdaq	2013	United States and England	71
8	Sun Link Health Systems, Inc.	AMEX	1995	United States	4
9	MEDNAX Inc.	New York	1995	United States	5
10	Medical Facilities Corporation	Toronto	2004	Canada - United States	5
11	Banmédica SA	Santiago	2001	Chile, Colombia and Peru	10
12	Clinica las Condes SA	Santiago	2009	Chile	1
13	Georgia Healthcare Group PLC	London	2015	George	37
14	NMC Health Plc	London	2012	UAE, Spain	7
15	Mediclinic International plc	London, Johannesburg and Namibia	1986	UK, South Africa, Namibia, Switzerland and UAE	73
16	Fresenius SE & Co.KGaA	Frankfurt	1986	Germany, Spain and USA	110
17	Rhön-Klinikum Aktiengesellschaft	Frankfurt	1989	Germany	38
18	Capio AB	Stockholm, Nasdaq Stockholm	2000	Sweden, Norway, Denmark, France and Germany	38
19th	Euromedica SA company	Athens, London	1999	Greece	12
20	IASO SA	Athens	2000	Greece	1
21	EMC Instytut Medyczny SA	Warsaw, Stockholm and France	-	Poland	8
22	Dom Lekarski SA	Warsaw	-	Poland	2
23	Ramsay Health Care Limited	Australia	1997	Australia, United Kingdom, Indonesia, Malaysia and France	223
24	Virtus Health Limited	Australia	2013	Australia, Ireland, UK, and Singapore	6
25	Life Healthcare Group Holdings Ltd	Johannesburg, Berlin, Frankfurt	2005	South Africa	64
26	Netcare Limited	Johannesburg	1996	South Africa and UK	116
27	IHH Healthcare Berhad	Malaysia and Singapore	2010	Malaysia, Singapore, Turkey and India	46
28	KPJ Healthcare Berhad	Malaysia	2007	Indonesia, Bangkok, Bangladesh and Australia	29
29	Raffles Medical Group	Singapore	2000	Singapore, China, Japan, Vietnam and Cambodia	1
30	RHT Health Trust	Singapore	2012	Singapore - India	2
31	Aikchol Hospital	Thailand	1992	Thailand	2
32	Bangkok Dusit Medical Services	Thailand	1991	Thailand and Cambodia	45
33	Chularat Hospital	Thailand	2013	Thailand	5
34	Chiang Mai Ram Medical Business	Thailand	-	Thailand	1
35	Mahachai Hospital PCL	Thailand	1996	Thailand	1
36	Nonthavej Hospital PCL	Thailand	1994	Thailand	1
37	Ramkhamhaeng Hospital PCL	Thailand	1991	Thailand	1
38	Samitivej PCL	Thailand	1990	Thailand	6
39	Vibhavadi Medical Center PCL	Thailand	1989	Thailand	1
40	Srivichai vejjivat PCL	Thailand	-	Thailand	3
41	Siloam International Hospitals	Indonesia	2013	Indonesia	20
42	Sarana Meditama Metropolitan Tbk PT	Indonesia		Indonesia	3
43	Concord Medical Services Holdings Limited	New York	2014	China	
44	Aier Eye Hospital Group Co., Ltd.	Shanghai	2015	China, Hong Kong and America, Germany, Austria, Spain and Italy	201
45	China Resources Phoenix Healthcare	Hong Kong	2013	China and Hong Kong	48
46	Apollo Hospitals Enterprise Limited	Mumbai Volkswagen Stock Exchange	1982	India	69
47	Dhanvantri Jeevan Rekha Ltd	Indian and Delhi National Exchanges	1996	India	1
48	Dr.Agarwal's Eye Hospital Limited	Indian National Stock Exchange	1995	India, Mozambique, Madagascar, Seychelles, Zambia, Uganda, Swaziland, Tanzania, Ghana, Nigeria and Rwanda	78
49	Shifa International Hospitals Ltd	Pakistan	1989	Pakistan	1

Table 3: Descriptive statistics of inputs and outputs of companies

Table 3: Descriptive statistics of inputs and outputs of companies								
Descriptive Statistics	Inputs			Outputs				
	Balance sheet items			Profitability ratios			Liquidity ratios	
	Current assets	Current liabilities	Equity	Return on Investment (%)	Return on Equity (%)	Return on Investment (%)	Current ratio	Quick Ratio
	Maximum	218.19	575.20	355.72	10.01	4.87	13.4	1.68
Minimum	29.68	44.28	-175.20	-7.05	-61.09	-15.8	1.41	0.99
Average	105.15	208.44	190.19	3.45	-27.55	3.87	1.58	1.14

Table 4: Relative Efficiency of Hospital Companies Based on Model CCR input-axis model

Row	Company	CCR- 2013	CCR- 2014	CCR- 2015	CCR- 2016
1	Community Health Systems, Inc.	0.92	0.95	1	1
2	HCA Healthcare, Inc.	1	1	1	1
3	Quorum Health Corporation	1	1	1	0.82
4	Select Medical Holdings Corporation	0.91	0.91	0.94	1
5	Tenet Healthcare Corporation	0.80	0.71	0.72	0.85
6	Universal Health Services, Inc.	0.89	0.86	0.96	0.89
7	LifePoint Health, Inc.	0.61	1	1	0.94
8	SunLink Health Systems, Inc.	0.47	0.49	0.77	0.34
9	Mednax Inc.	1	0.89	1	1
10	Banmédica SA	0.53	0.39	0.75	0.82
11	Clinica las Condes SA	0.96	0.85	0.75	0.75
12	Georgia Healthcare Group PLC	0.57	0.80	0.72	0.72
13	NMC Health Plc	0.63	0.52	0.93	0.96
14	Mediclinic International plc	0.98	0.98	1	0.79
15	Fresenius SE & Co.KGaA	0.70	0.68	0.87	0.78
16	Rhön-Klinikum Aktiengesellschaft	0.79	1	0.54	0.57
17	Capio AB	0.44	0.43	0.47	0.51
18	Euromedica SA	1	1	1	1
19	IASO SA	0.58	0.23	0.73	0.59
20	EMC Instytut Medyczny SA	0.53	0.44	0.46	0.30
21	Dom Lekarski SA	0.40	0.35	0.72	0.53
22	Ramsay Health Care Limited	0.70	0.64	0.85	0.95
23	Virtus Health Limited	1	1	1	1
24	Life Healthcare Group Holdings Ltd	1	1	1	1
25	Netcare Limited	1	0.54	0.85	0.77
26	IHH Healthcare Berhad	1	1	1	0.90
27	KPJ Healthcare Berhad	0.39	0.31	0.52	0.54
28	Raffles Medical Group	0.87	0.77	0.62	0.56
29	RHT Health Trust	0.87	1	0.67	1
30	Aikchol Hospital PCL	1	1	1	1
31	Bangkok Dusit Medical Services PCL	0.83	0.79	0.82	0.89
32	Chularat Hospital PCL	1	1	1	0.94
33	Chiang Mai Ram Medical Business PCL	0.60	0.51	0.75	0.79
34	Mahachai Hospital PCL	0.60	0.52	0.73	0.75
35	Nonthavej Hospital PCL	1	1	1	1
36	Ramkhamhaeng Hospital PCL	0.77	0.82	0.97	1
37	Samitivej PCL	0.85	0.89	0.99	1
38	Vibhavadi Medical Center PCL	0.60	0.47	0.76	0.84
39	Srivichai vejjivat PCL	0.51	0.58	0.57	0.74
40	Siloam International Hospitals	0.95	0.66	0.54	0.86
41	Sarana Meditama Metropolitan Tbk PT	1	0.85	1	0.82
42	Concord Medical Services Holdings Limited	0.38	0.51	0.37	0.51
43	Aier Eye Hospital Group Co., Ltd.	0.65	0.76	1	1
44	China Resources Phoenix	0.75	1	0.96	0.93
45	Apollo Hospitals Enterprise Limited	0.74	0.77	0.79	0.77
46	Lotus Eye Hospital and Institute Limited	1	0.86	0.93	1
47	Dhanvantri Jeevan Rekha Ltd	1	0.66	0.74	0.71
48	Dr.Agarwal's Eye Hospital Limited	0.41	0.31	0.90	0.36
49	Shifa International Hospitals Ltd	0.74	0.53	0.71	0.92

Table 5: The reliability of the variables through the LLC test

Variable	P rob
Return on Investment (ROA)	0.00
Return on Equity (ROE)	0.00
Return on Investment (ROI)	0.02
Current Ratio(CR)	0.01
Quick Ratio (QR)	0.00

Table 5 shows that dependent and independent variables were reliable during the research period because the p-value for this test is less than a 5% significance level. Next considers the appropriate model for the regression model, from two models, Panel and Pool Data. In the pool data, the opposite of panel data, it is possible to ignore the factor of the section (company) or the factor of time (year) and combine the data with each other and estimate it by a regular least squares regression. In this regard, the F lemmer test was run to measure whether the data are panel or pool type. The hypotheses H0 and H1 for this test are

H₀: Data can be combined and a pool data model can be used.

H₁: Data cannot be combined and a panel data model can be used.

Table 6: Results of F lemmer test.

Test	test statistic	The degree of freedom	P rob
F lemmer	7.2	48 and 140	0

In Table 6, the p-value for the F Lemmer test is less than the 5% significance level. The hypothesis of the use of pool data has to be rejected and the panel data model can be used. In order to estimate the regression, we have two methods: Fixed Effect and Random Effect. We employed the Hassman test to select the appropriate method between them. The hypotheses for this test are:

H₀: No relationship between independent variables and estimation error (random effects method)

H₁: A relationship between independent variables and estimation error (Fixed Effect method)

Table 7: Results of Hausman Test

Test	Chi-Sq	Degree of freedom	P rob
Hazeman test	7.62	7	0.36

The results of the Hausman test are presented in Table 7. Since the p-value related to the Hasmane test is more than a 5% significance level, the panel data with random effects was selected, which indicates that there is no relationship between the independent variables and the estimation error.

In the following, the significance of the regression model was investigated, the results of which are shown in Table 8. Findings show that the correlation between the dependent variables (efficiency) and the independent variables (profitability and liquidity ratios) is strong ($R = 0.768$). Also, the profitability and liquidity ratios can explain 67% of the variation of efficiency ($R^2 = 0.67$). With a 5% error rate, it can be stated that the regression model significantly predicts performance changes per year ($p = 0.00$).

Table 8: Results of the test of hypotheses through regression.

Variable	Coefficient	Std Error	t-statistic	Prob
Efficiency	1.0573	0.2473	4.2754	0
Return on Investment (ROA)	-0.0003	0.0040	-0.0921	0.9267
Return on Equity (ROE)	7.98 E- 06	0.0001	0.0571	0.9546
Return on Investment (ROI)	0.0031	0.0024	1.2661	0.2076
Current assets (E quity)	-0.0043	0.0024	-1.8211	0.0707
Current liabilities (L liabilities)	-0.0037	0.0027	-1.3719	0.1723
Quick (QR)	0.0143	0.0431	0.3312	0.7410
Current ratio (CR)	0.0622	0.0394	1.5784	0.1167
Effects Specification				
R-squared	0.7681	Mean dependent var		0.7871
Adjusted R-squared	0.6770	S.D.dependent var		0.2075
S.E.of regression	0.1179	Akaike info criterion		-1.2026
Sum squared resid	1.9468	Schwarz criterion		-0.2659
Log-likelihood	173.85	Hannan-Quinn criteria.		-0.8234
F-statistic	4335.8	Durbin-Watson stat		2.2754
Prob(F-statistic)	0.00			

4. DISCUSSION

In this research, identification of the companies of listed hospitals in the capital market and evaluation of efficiency were studied. As the findings demonstrate, in the world, in addition to the defined models, hospitals have been registered as a public company that is active in the capital market. Some of these companies having one hospital and some of these companies are active in Holding and have more than one hospital in the capital market. Some holdings are international and are operating in locations around the world. Measuring the efficiency of hospital companies showed that they are growing in the period of 2013-2016 and have a relatively good average performance (78.5%).

Since there has been no research on identifying hospital companies in the capital market and measuring their efficiency, researchers have compared the performance of hospital companies with other hospital companies not listed in the capital market. The results of studies conducted on hospital companies showed that the efficiency of hospitals has increased since becoming a company. In this regard, we can mention the Ferreira & Marques study, which shows that corporate government hospitals have the highest degree of efficiency stability (Ferreira & Marques, 2015). The efficiency of hospitals in Portugal has increased since they became corporative (Rego et al., 2010). Moreira (2008) showed that corporate hospitals have become more efficient. In their study in Sweden, improvements in production and financial resources have occurred in hospitals by corporatization (Aidemark & Lindkvist, 2004; Farzadnia et al, 2017).

The results of the research showed that there is a positive correlation between the efficiency and the ratios of profitability and liquidity. Eskandari and Mirza (2014) explained the significant effect of liquidity ratios and equity ratios on the technical inefficiency of companies is. Dadkhah et al. (2010) evaluate the efficiency of automobile parts manufacturing companies active in the Tehran Stock Exchange, concluding that there is a significant relationship between efficiency and stock returns. They argue, however, that the stock returns of efficient companies are higher than inefficient companies (Dadkhah et al., 2010) Abaszadeh et al. (2013) reviewed the relationship between capital structure and the efficiency of companies admitted in Tehran Stock Exchange and found that the debt ratio has a significant relationship with the efficiency of the companies. However, in the study of Janshad et al. (2009), which examines the efficiency of companies admitted

in the capital market, revealing that there is no significant relationship between the efficiency of cement and mining companies and the annual stock returns of companies. They stated that one of the reasons for the lack of a relationship is the limitation of the period of time (Jahanshad et al., 2009).

5. CONCLUSION

We performed the identification of hospital companies listed in the capital market, efficiency evaluation and examining the relationship between efficiency and profitability and liquidity ratios. Efficiency evaluation of hospital companies demonstrated that their efficiency is increasing and have relatively good efficiency. An increase in the efficiency of hospital companies, given the direct correlation between efficiency and profitability and liquidity ratios, indicates the potential of companies to fulfill financial obligations and a positive evaluation of the companies' performance.

4. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

5. REFERENCES

- Abaszadeh, M., & et al. (2013). Survey the Relationship between Capital Structure and Performance of Companies Accepted in Tehran Stock Exchange Using Data Envelopment Analysis Technique. *Journal of Stock Exchange* (9).
- Abolhalaj, M. (2010). Basics changes in public financial system, change from cash to accrual accounting method. Tehran: Sarnaveshtsazan.
- Abullhlaj, M., & et al. (2015). A look at the private, public participation in the hospital sector with emphasis on chain hospitals. Tehran: Islamic Parliament Research Center .
- Aflatoonan, A. (2018). Statistical analysis with EViews in accounting and financial management research. Tehran: Termeh.
- Aidemark, L.-G., & Lindkvist, L. (2004). The vision gives wings: A study of two hospitals run as limited companies. *Management Accounting Research* (15), 305-318.
- Barbosa F. (2018). Emergency Health Care System and its Role in National Disasters. *Journal of Humanities Insights*, 02(01):14-20.
- Dadkhah, M., et al., e. (2010). Assessment of relative financial efficiency of companies active in the manufacturing of automobile parts accepted in Tehran Stock Exchange using the DEA and its relationship with stock returns. *Financial Accounting Journal*, 2(8), 113-133.
- Daniali, M., & Mansouri, H. (2012). Efficiency of Tehran Stock Exchange at weak level and prioritize the factors affecting it. *Quarterly Journal of Economic Research*, 12(47), 71-96.
- Dargahi, H., et al., e. (2010). The Efficiency analysis of Medical Records Departments of Tehran University of Medical Sciences Hospitals with Data envelopment analysis (2007-2009). *Payavard Salamat*, 4(2), 9-17.
- Eskanderi, M., & Mirza Mohamadi, S. (2014). Evaluating the Effect of Financial Performance and Privatization on the Technical Efficiency of Listed Companies in the Stock Exchange. *Asset management and financing Journal*, 2(3), 93-108.
- Farzadnia, E., Hosseini, Z., & Riahi, A. (2017). Study of Hospital Quality Management and Improvement Rates in the Hospitals. *Journal of Humanities Insights*, 1(1), 7-11.
- Ferreira, D., & Marques, R. (2015). Did the corporatization of Portuguese hospitals significantly change their productivity? *Eur J Health Econ* (16), 289–303.
- Jahanshad, A., Pourzamani, Z., & Ajdari, F. (2009). Survey the efficiency of companies accepted in Tehran

Stock Exchange using data envelopment analysis method and its relation with stock returns. Financial Accounting and Audit Research Journal, 109-128.

Mehregan, M.(2011). Data Envelopment Analysis, quantitative model for evaluating the performance of organizations.Tehran: Academic book publishing.

Mohamadi, A., & Dastyar, H. (2015). Evaluating Efficiency of Pharmaceutical Companies and Their Ranking via Data Envelopment Window Analysis. Health accounting, 2(3), 23-39.

Moreira, S.(2008). Efficiency analysis of public hospital transformed into public corporations. Economic Bulletin, Banco de Portugal, 119-141.

Pham, C.(2013).Financial Privatized State Owned Enterprises: Lessons Learnt from Vietnam. Retrieved from <https://ssrn.com/abstract=2362435>

Preker, A.S., & Harding, A. (2009). Innovations in Health Service Delivery, The Corporatization of Public Hospitals.The International Bank for Reconstruction and Development. The World Bank.

Rego, G., Nunes, R., & Costa, J. (2010). The challenge of corporatisation: The experience of Portuguese public hospitals. The European Journal of Health Economics. (11), 367-381.

Securities and Exchange Organization. (2016). Step by step Exchange training. Retrieved from Informative company of Stock Exchange: <http://stock.shahr-bank.ir>

Shakibae, A., & Golmohamadi, M.(2014). The Effect of Acceptance of Companies in the Stock Exchange on Productivity: Data Envelopment Analysis (DEA). Journal of Economic Research and Policy, 22(70), 103-118.



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Note: This study is extracted from the author's Ph.D. Dissertation entitled "Designing an Appropriate Financing model for public hospitals accepted in Stock Exchange Market" submitted to the Faculty of Management, South Tehran Branch, Islamic Azad University, Tehran, Iran.

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TRANSDISCIPLINARY APPROACH TO THE LEARNING PROCESS ORGANIZATION IN THE E-LEARNING INFORMATION ENVIRONMENT OF A COLLEGE

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ABSTRACT

The work relates to the professional teaching to the problem of teacher training, taking into account the current social challenges and the learning process management in college. This article focuses on the effectiveness of applying the transdisciplinary approach in the learning process organization when training future teachers in college in the context of e-learning implementation. Analysis of foreign and Russian scholars' theoretical positions on the issues of college educational management and the teacher training organization in the e-learning information environment is the leading approach to the case study, at the Ammosov North-Eastern Federal University (NEFU) focusing on training competitive specialists with a high level of professional thinking and managerial and educational culture. The method involves interviews more than 250 NEFU students pursuing a master's degree in Preschool Management, Project Management in Education, Innovative Processes in Education, Corporate e-Learning, and Technology and e-Learning management in the Teacher Training Institute at NEFU. The survey objectives were to study the level of formedness of professional, personal, and specialized competencies in future teachers.

Disciplinary: Education Sciences (College Education), Information Technology (Elearning).

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1. INTRODUCTION

The interest of modern pedagogical science and education practice to establishing interdisciplinary links, developing students' and teachers' skills and abilities in pedagogical and humanitarian areas, enhancing their information and technological activities in accordance with the realities of innovative development in Russian society is very high. The globalization of society and development of information technologies require constantly updating ways to acquire and use knowledge. At present, the system of higher vocational education assumes the transdisciplinary nature of its organization with the aim to achieve fundamentality, a quality level of education, versatility, and universality of individual knowledge and to solve complex problems in the nature-man-society system. The transdisciplinary approach is one of the promising approaches to the teacher training development in the North, since ethnocultural education is essentially natural and interdisciplinary in essence.

The modern educational policy of the Russian Federation assigns a strategic goal to the scientific community: to create conditions for domestic education competitive development in terms of the general education quality in the context of globalization for Russia to rank among the top ten countries in school education quality by 2024. The quality of education is defined by the state of the teaching community: teachers' qualifications and professionalism, readiness to search for new solutions in the field of training and education, creating conditions to accompany the life cycle of teacher's profession, including admission of talented young people to teacher training programs.

Analysis of the teacher training practice in universities of the Russian Federation has revealed the following trends: development of interaction between schools and colleges and a network partnership of educational establishments; development of diversified educational routes for teacher training in college, expansion of master's degree programs aimed at training educational managers; introduction of innovative training technologies aimed at improving the quality and efficiency of the learning process; implementation of a point rating system for monitoring students' knowledge; stepping up the requirements for academic research and social work of students, development of academic mobility programs for future teachers; stepping up the requirements for teaching and academic staff; the enhancing employability of graduates, which ensures a high rate of their employment and a steadily growing number of young professionals in educational institutions (Mikhaylova, 2015).

The research is conditioned by the need to study the pedagogical capacity of digital education in the training of future teachers in college, which is continuously and intensively associated with the use of electronic educational resources. Solving this problem requires studies and analysis by foreign and domestic researchers and subsequent development of new science-based academic syllabi focused on teacher training targeting the use of digital educational technologies and methods in teachers' professional practice as well as testing these syllabi in teacher training colleges of the North-East of Russia.

2. LITERATURE REVIEW

Transdisciplinarity is understood within different meanings, since the term itself is multidimensional as well as its semantic content. Its basic interpretations are the following: transdisciplinarity implies the principle of scientific research that goes beyond the scope of academic disciplines. Jean Piaget describes transdisciplinarity as a way to force scientific endeavor to go beyond science in the course of global synthesis of the world comprehension forms (Kolesnikova,

2014, Molchanov, 2013). Cognitive situations are called transdisciplinary if, for various reasons, the scientific mind has to transcend into the border zone with the vital world in search of integrity and its own validity in these situations (Kiyaschenko, 2009).

The transdisciplinary approach is an interdisciplinary scientific direction of structurally organized evolving systems that include the system of vocational training of educational management specialists. This approach provides a new way for expanding scientific and pedagogical knowledge focused on multidimensionality, complexity, and polyphony (alternativeness and variability) of the processes being cognized, discovering undisclosed or insufficiently disclosed states in them, and recognizing the meaningful role of chance in their development. The system of college education is capable of self-organization if it meets a number of requirements: it is complex, open, nonlinear, and stochastic, reaches a state of instability, and has sources as well as energy and information stocks.

Recently, the Russian educational system has been rapidly improving and developing. One of the areas that have served as a development basis for almost all life spheres in the 21st century, including education, is the implementation of digital education. E-learning is increasingly seen in research as the most effective type of learning that allows for the learning process optimization, especially in an economic downturn (Vlasova, 2014). According to the analysis of regulatory documents for the e-learning implementation in schools and colleges of Russia, the educational, teaching and research process and research activities of students comply with the Federal Educational Standard (FES), which indicates particular importance of the education informatization process in general and in particular of the use of e-learning and distance learning technologies (Marchuk, 2013). At the same time, the essence and specificity of implementing digital education in the process of schoolteacher training have not been sufficiently studied in the regional education system of the Republic of Sakha (Yakutia) (Barakhsanova, 2015). We believe that theoretical understanding of implementing digital education in the colleges of the Republic of Sakha (Yakutia) has allowed us to solve the following problems that are necessary to identify the specifics of digital education in schools and colleges, in determining the essence of students' digital dependence in educational activities and in practice (Barakhsanov et al., 2018).

Foreign researchers have accumulated vast experience in the use and development of digital education in various aspects of educational activities. Levin (2013) proposes a conceptual model of a new education system defined by three levels that affect education: social media as a new way of shaping public consciousness; personal online identity as a new way of personality formation, and Data Intensive Science as a new methodological paradigm. It is believed that these three phenomena originate from the evolution of three relevant areas where three fundamental phenomena, that is, social media, online self-identification and Data Intensive Science, have assumed great importance in the context of social media, whereby the abundance of diverse content that stimulates students' personality development online is a new type of education which fundamentally changes all its components: content, curriculum, and the learning environment. Walton (2015) addresses the relationship between results and value, selection processes and some attributes of information and explores how this relationship changes when moving from analogue to digital information. The article of Rosado (2006) explains that literacy does not only provide methods and tools for working with texts and figures in a specific cultural and ideological context but also makes a significant contribution to enriching the human thinking capacity with its subsequent transformation. This intellectual

enrichment occurs whenever humanity acquires new cognitive tools such as writing or such technical tools that digital technology has made possible. Belshaw (2012) notes the following eight components for the development of digital literacy: cultural, cognitive, constructive, communicative, confidential, creative, critical. and collective.

It should be noted that the analyzed papers do not sufficiently reflect the problem of studying digital education and its implementation mechanisms in the field of education that would take into account the specifics of national and regional educational systems of the Arctic Zone of the Russian Federation (AZRF), as well as in professional activities.

3. METHODOLOGY

The theoretical foundations of the research were laid by the works of Russian authors on e-learning, belonging to two schools of thought – NEFU Professor E.A. Barakhsanova (2017; 2018) and Herzen University Professor E.Z. Vlasova (2018) and learning using digital technology.

What we mean by transdisciplinarity is a high level of academic literacy, diversity of thought, and pansophy of an individual. In these terms, this approach virtually becomes a priority in the modern educational system, since it fully aligns with the principle of competency-based approach in teacher training. In this context, let us consider the concept of professional competence has been assigned numerous definitions. Based on the definition of Kodzhaspirova (2004), we define professional competence as an integral criterion for the quality of vocational training, professional activities, and personality traits, which characterizes a high level of human performance, work culture, and interpersonal communication, the ability to solve job-related problems in an proactive and creative way, as well as skills to manage social economic, legal, psychological and moral aspects of activity, the willingness to make managerial decisions, to be flexible and to adapt to a new operational environment. In this definition, the transdisciplinary essence of the competency concept as such is especially clearly in evidence, since its wording remains debatable in the educational theory. The immediacy of the problem is determined by the need to acquire certain competencies and holistic professional competence as a result of teacher training in college. As can be seen from this definition, the very principle of graduate's competence goes beyond the scope of science learnt by students; in addition, it affects the social, legal and other aspects of their activities, the objective (professional skills) and subjective (personal qualities) components. Khutorskoy (2003) determines professional competency as a certain personal characteristic, while competencies are a set of specific professional or functional characteristics, according to him. The concept of competency has become increasingly common at the common didactic, general pedagogical and methodological level, which is associated with its system-practical functions and integrative meta-subject role in education (Khutorskoy, 2003). According to him, the following components of all-objective (meta-subject) content of education are fulfilled, concentrated, and interconnected in the key educational competencies: real-life objects of the studied reality; universal cultural knowledge about the studied reality; general educational skills, expertise, and methods of activity. In the way of evidence, the author cites definitions of a “core competence” given by his colleagues, which can also be the rationale for the transdisciplinarity of basic concepts of the competency-based approach.

Based on the research analysis, the following basic approaches to the learning process in teacher training at Russian universities have been determined: knowledge (traditional), system-activity, humanistic, learner-centered, competency-based, archeological, and synergetic (Table 1).

Table 1. Approaches to teacher training in college education

Name of approach	Description
Knowledge	Education should be aimed at building solid academic knowledge in a future educational manager. Requirements for graduates involve acquisition of knowledge and skills to allow them to methodically process the content of education and to transfer it.
System-activity	Aimed at developing students' ability to design, forecast, and program their professional activities. The training is a triad that includes a system of formation of personal qualities and professional attributes, a system of professional educational culture, including mandatory formation of standard professional activity components and an interdependent system of their interaction.
Humanistic	It is believed that the identity of an educational manager comprises professional capabilities and individual psychological characteristics that are naturally interwoven. Therefore, such specialist training should be based on humanistic values realized and accepted by the individual as the essence of managerial and educational activities.
Competency-based	Education is focused on an internal change of value, need, and motivational structures of an individual, their interests, attitudes, standpoints, and personal meanings in mastering knowledge, skills, and methods of activity. It prioritizes personal goals and meanings in students' minds, while bringing social values and social meanings of mastering the system of competencies to a higher level.
Learner-centered	The need to form a value-based attitude to innovative practices as an individual and social mechanism of positive changes in college graduates, the implementation of which implies a creative and conscious transcendence beyond the traditional goals and methods of activity.
Acmeological	The manager training system in college should be focused on developing individual qualities and abilities that would ensure formation of a professional culture and development of professionalism
Synergetic	The possibility to take a new approach to tackling the problems of pedagogical system development, primarily considering it from the standpoint of "openness", co-creation and orientation towards self-development. Training a specialist with a wide range of professional skills results from the learning process organization. The learning process is a system that is in a state of flux and permanent self-development; the reality being cognized is a system containing multiple developing elements. Any learning system is a synergetic and self-organizing system.

The literature review shows that transdisciplinarity is aimed at attaining one of the most challenging objectives of the modern educational system—its transition to creative problem training and education methods that would ensure formation of a creative personality and development of their intellectual potential (Anufriyeva, 2009; Bulayeva, 2009; L. Darling-Hammond 2006; Foster, 2004; Zhidkikh, 2012; Miller, 2010; Mikhaylova, 2015; Kotova, 2016; A.D. Nikolayeva et al., 2016; Samsonova, 2009; Zaragoza 2017, Zeichner 2005).

We believe that the teacher training in the field of education requires taking into account and implementing certain principles to ensure formation of a creative personality of a future professional: 1) the principle of recognizing the inherent worth of a student's personality that is understood as an open opportunity in the learning process; 2) the principle of fluctuation (deviation) of creative thinking, whereby no functional system is stable, it inevitably accumulates deviations that can lead to chaos and even cause its disintegration; 3) the principle of inconsistency of the intellectual development process, whereby self-organization is possible with the system heterogeneity and with non-equilibrium structures, while self-development is understood as a self-actualization of the system's existing potential.

The need for the transdisciplinary approach to the learning process organization is conditioned by the fact that the subject system of higher vocational education is focused on independent academic disciplines that are clearly demarcated from one another, which moderates the process of establishing

and developing interdisciplinary links that are the most important imperative for the modern specialist training. Thus, interdisciplinary links are implemented through integrated courses that form the integral type of knowledge.

The use of transdisciplinary approach allowed for development of master's program "Corporate e-Learning" as an integrated system interconnected with the quality of education in college and providing an integrated approach to specialist training in the field of distance education, as well as training administrative officers and executive employees for the educational management authorities of various types.

The transdisciplinary approach involves a transfer of complete information blocks that give an overall picture of the world rather than that of a single phenomenon or problem. According to this principle, NEFU has developed the following training modules: Philosophical and Methodological Foundations of Pedagogical Research; Modern Information Technologies in Education; and Design in Education, including Research Activity.

Intramodular links among disciplines are an interdisciplinary synthesis of knowledge, illustrating profound changes in the methodological foundations of modern science, in the philosophical view of life, and in the very style of scientific thinking style. Thus, the module Philosophical and Methodological Foundations of Pedagogical Research reveals through studying the philosophy of science and education, contemporary issues in science and education, as well as the methodology of educational research. The course contents in this module draw on each other and at the same time serve to supplement each other.

We believe that the area for a professional fulfillment of masters' skills is not limited. A graduate may be sought after in national and municipal administration bodies, particularly, in state and regional education departments and scientific committees.

4. RESULTS

In order to study the students' beliefs about the teaching activities and to assess the formedness level of their professional, personal, and specialized competencies in learning, we conducted a survey among 250 students pursuing graduate studies in the following master's programs: Preschool Management, Project Management in Education, Innovative Processes in Education, Corporate eLearning, and E-learning Technology and Management at the NEFU Teacher Training Institute.

According to the survey results, 40% of the first and second students have no work experience, which indicates that the students have little idea of the job factors in their future professional engagement. 22% of the students have work experience up to one year long, the smallest percentage of respondents have from one to five years of experience—16% of students, 12% of the survey participants have from five to ten years of experience, and more than 8% of graduate students—over ten years (Table. 2).

The questionnaires included questions to evaluate the graduate students' competencies according to the degree of their indispensability for effective work in the field of education, as well as questions about their strengths and weaknesses as educational management graduates; they also had to outline proposals for improving their professional competencies.

Thus, when evaluating their managerial competencies, 87% of students respond that the ability to plan their activities and organize them is the most important along with having decision-making skills, 53% of students believe that leadership skills are required for efficient performance of an executive manager, while 18% of students mark delegation skills as mandatory competencies. In our

opinion, it is caused by the lack of management practice, whereby allocation of functions, delegation skills, and the ability to determine one's own leadership potential are required.

In evaluating the communication competencies, the students identified persuasion skills (87% of respondents), the ability to make contact (74% of respondents), and flexibility (71%), while only 51% of respondents mentioned the teamwork and listening skills as necessary competencies for successful managerial performance in education. We believe that this is caused by the lack of experience in real teams and insufficiently formed communicative skills. In evaluating personal competencies, the students noted responsibility (93%), the willingness for self-improvement (68%), and the ability to cope with stress (52%) as competencies critically needed by educational managers, while only 35% of students consider creativity as a mandatory competency of a teacher. Also, only the ability to apply knowledge in practice was identified by the students as a specialized competency necessary for a teacher (59%). The remaining competencies were estimated as optional by the students. Perhaps this is due to their poor awareness of a specific area of future professional engagement and the lack of practical experience.

When describing their strengths, the students mentioned communication skills, a creative approach to solving problems, a high career motivation, and the ability to plan and monitor performance. Among their weaknesses, the students pointed out the lack of job-related experience and inability to apply theory to the practice.

To develop the professional competencies and make changes in the learning process, the students mentioned the need to and proposed to increase the number of hours in on-the-job training program, to arrange internships with subsequent employment, to increase the amount of practical training with simultaneous reduction of classroom session time, and to organize practical training in the form of workshops targeting specific competencies. In addition, there were proposals to organize competence sharing meetings with successful educational managers from different institutions.

As an example regarding E-learning in machine learning can point to that once the data is available, we move into the iterative Data Science workflow of model building. This usually involves splitting the data into a training set and a validation set, trying different combinations of algorithms, and tuning their parameters and hyper-parameters. That produces a model that can be evaluated against the validation set, to assess the quality of its predictions. The step-by-step of this model training process becomes the machine learning pipeline.

Figure 1 shows how we structured the ML pipeline for a sales forecasting problem, highlighting the different source code, data, and model components and all of these are the product of E learning approach. The input data, the intermediate training and validation data sets, and the output model can potentially be large files, which we do not want to store in the source control repository. Also, the stages of the pipeline are usually in constant change, which makes it hard to reproduce them outside of the Data Scientist's local environment.

5. DISCUSSION

Based on the understanding of professional becoming in the field of project management in education as a complex process that should be comprehended from various perspectives, we have developed the educational module Project Management in the Context of Education Modernization that includes the following subjects: Strategic Development of Educational Systems based on Project Management, Expert Project Management in Education, Legal Framework of Project Management,

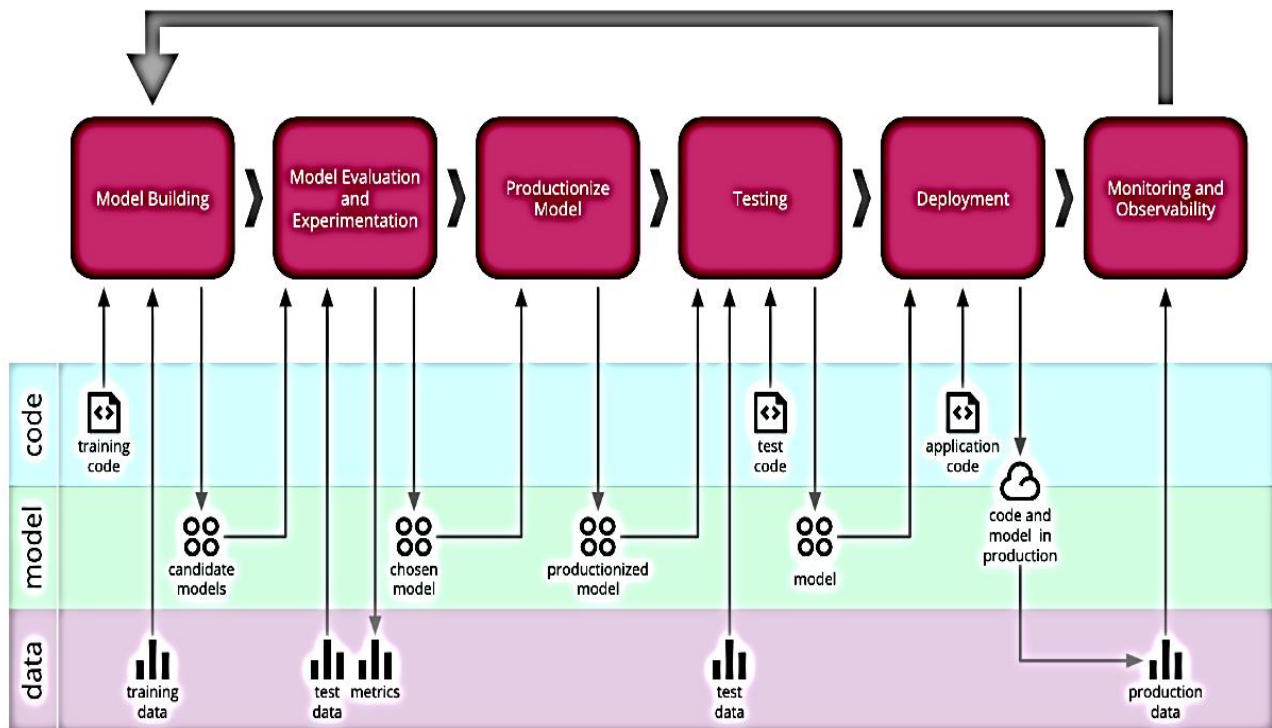


Figure 1: Machine Learning pipeline for our Sales Forecasting problem, and the 3 steps to automate it with DVC

The content and purpose of studying these disciplines allow one to create a modular integrated course with the aim to form all-objective skills in cognitive, evaluative, communicative, and creative activities, taking into account the competency-based approach and using the knowledge gained in the process of studying pedagogy, psychology, etc.

The choice of the proposed disciplines was agreed with the employer's order, which is contained in the professional profile of educational project management masters.

In our opinion, this is expressed in the ability to design an educational environment that would ensure the educational process quality; in studying the state and potential of the controlled system and its macro- and microenvironment by using a suite of strategic and operational analysis methods; in research, organization and assessment of implementing the management process outcome using management technologies that comply with common and specific patterns of the controlled system development; in using the existing potential of the controlled system environment and designing ways to enrich and develop it to ensure management quality.

It is important for a future educational manager to develop personal and professional qualities that would contribute to the formation of readiness to hold personnel together, of communicative and leadership skills expressed in the ability to establish business contacts, to make a good impression, in openness to dialogue and discussion and focus on mutual consent; of the ability to stimulate the proactive attitude of employees for their professional fulfillment; the ability to ensure seamless interoperability of the team members.

These are exactly the personal and professional qualities of a future manager that will later help them build up conflict-free relationships with the staff, to hold the team members together and, basically, to proactively manage the staff. To ensure formation of these professional competencies, graduate students should develop individual learning routes for on-the-job training with the guidance

of an internship mentor.

This approach is based on self-study, self-organization, and self-management dominating their activities and consists in a stimulating or motivational effect on an individual aimed at their self-realization (Knyazeva, Kurdyumov, 2002).

Thus, when training future educational managers upon completion of the master's programs "Project Management in Education" and "Management in Vocational Education" at NEFU, the graduates are expected to have acquired common cultural, general professional, professional proper and specialized competencies.

Professional competencies are designed by types of activity in accordance with the Federal State Educational Standards of Higher Education 44.04.01 Teacher Training, where management, research and development, project and teaching activities have top priority.

Interdisciplinary integration is carried out on the basis of cyclic, interdisciplinary and intradisciplinary links and is a logically complete structure of multidisciplinary knowledge. Such integration does not merely supplement the content of one discipline with some knowledge from another, instead, it integrates them; it does not provide discipline-specific training, but rather activity-based that would form professionally important skills, abilities, and personal qualities (Vishnyakova, 2007).

The formation of scientific concepts on an interdisciplinary basis is facilitated by the following pedagogical, common didactic and psychological conditions:

- 1) study of individual academic disciplines coordinated in time, whereby each of them draws on the preceding conceptual framework and prepares students for efficient assimilation of concepts from the subsequent discipline;

- 2) the need to ensure continuity and consistency in concept development; concepts that are common to a number of disciplines should be continuously developed from one academic discipline to another, filled with new content, and enriched with new links;

- 3) unity in the interpretation of general scientific notions;

- 4) avoiding overlap of the same concepts in studying different subjects;

- 5) implementing a consistent approach to defining identical classes of concepts (Chebyshev, 1998).

When fulfilled, these functions allow for all-round education of students, which is why the educational function is an integrating function.

Integrated courses can become the most acceptable way of forming an integral type of knowledge with the existing subject-block educational system. Their development and construction methods vary and depend on the goal setting, the degree of involvement of the integrated disciplines in the general problem field, the nature of interdisciplinary links (direct or mediated) and, ultimately, on the authors' individuality of the developers.

Creating a module imposes the following mandatory requirements:

- time consistency in the study of individual academic disciplines, whereby each of them draws on the preceding conceptual framework and creates the basis for efficient assimilation of concepts on an interdisciplinary basis;

- continuity and consistency in concept development, providing for their continuous development, filling with new content, and enrichment with new links;

- unity in the interpretation of general scientific notions;
- implementing a consistent approach to the learning process organization in all the module components.

At the present stage, interdisciplinary integration is impossible without the education informatization. One of its focus areas is creating interdisciplinary network educational and methodical complexes consisting of a working syllabus of a subject; guidelines for practice and laboratory operations; assignments for individual student's work; assessment tools; sample questions to prepare for an exam or test; guidelines for writing a thesis (if included in the curriculum); a reference list and Internet resources; an online lecture course; materials for additional in-depth study of the discipline; criteria for assessing learning outcomes.

The complex of the above disciplines complies with the principle of initial course modularity, since it implies a clearly structured material, dynamic presentation, the relevance of the knowledge gained, the ability to apply various didactic tools, such as integrated lectures, design, etc.

The problem is that a future specialist must possess skills and professional mobility to promptly respond to constantly emerging changes in their practical activities and scholarly endeavor.

Thus, interdisciplinary integration is one of the most important areas for improving modern college education.

6. FINDINGS

The vocational training process is considered as a holistic and synergetic educational system centered on the personality of a student that is, in turn, also a complex self-organizing system.

It is necessary to emphasize that systems including several multiple-system components that constitute an integral synergetic system are actually implemented in the context of diversity, fragmentarity, randomness, spontaneity, and unpredictability.

Currently, the use of synergetic approach plays an enormous role in professional becoming of an educational manager, whereby the result of learning process organization is a trained specialist with a wide range of professional skills.

Some of these qualities are specific to a manager, while others are more general in nature and are considered mandatory for graduates of any teaching programs. When training an educational manager, the multi-variance stands for creating conditions of choice and providing each person with a chance to take an individual route to success in the college educational environment, thereby stimulating the independent choices and responsible decisions, ensuring the development of an alternative and independent path. More specifically, this choice is the ability to determine an individual education path and the rate of learning, to achieve different levels of academic literacy, to choose the type of institutions, academic disciplines and teachers, forms and methods of teaching, individual tools and techniques, drawing on synergetic principles of pedagogy.

7. AVAILABILITY OF DATA AND MATERIAL

Information used and generated from this work is available by contacting the corresponding author.

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9. REFERENCES

Anufrieva, N. I. (2009). A systematic approach to the training of a teacher-musician. Monograph. Moscow.

- Barahsanova, E. A., & Varlamova V. A. (2015). Educational and methodological support for the implementation of the principle of regionalization of education in the process of teaching a block of information disciplines. *Modern problems of science and education*, 5, 522.
- Barakhsanov, V. P., Barakhsanova, E. A., Olesov, N. P., & Prokopyev, M. S. (2018). E-learning system application for physical education and sports specialist training. *Theory and Practice of Physical Culture*, (7), 4-4.
- Barakhsanova E. A., Vlasova, E.Z., Golikov A. I.; Kuzin Z. S., Prokopyev, M.S., Burnachov A. E. Peculiarities of quality management of teachers' e-learning training in the Arctic regions. *Education*, 2018. 38(55), 25.
- Bawden, D., & Robinson, L. (2016). Into the infosphere: theory, literacy, and education for new forms of document. 177-186
- Belshaw, D. (2012). *What is 'digital literacy'? A Pragmatic investigation* (Doctoral dissertation, Durham University).
- Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of teacher education*, 57(3), 1-15.
- Foster, W. P. (2004). The decline of the local: A challenge to educational leadership. *Educational administration quarterly*, 40(2), 176-191.
- Gounko, T., Panina, S., & Zalutskaya, S. (2016). Establishing world-class universities in Russia: case study of a federal university. In *Assembling and Governing the Higher Education Institution* (pp. 331-348). Palgrave Macmillan, London.
- Gounko, T., Panina, S., & Zalutskaya, S. (2016). Establishing world-class universities in Russia: case study of a federal university. In *Assembling and Governing the Higher Education Institution* (pp. 331-348). Palgrave Macmillan, London.
- Kiyashchenko, L. Ya., & Moiseev, V. I. (2009). The philosophy of transdisciplinarity. Moscow: Russian Academy of Sciences. URL: <http://transstudy.ru/filosofiya-transdisciplinarnosti>.
- Knyazeva, E. N. (2011). Transdisciplinary research strategies. *Vestnik TGPU*, 10(112), 193-201.
- Knyazeva, E. N., & Kurdyumov, S. P. (1999). Synergetics and new approaches to the learning process. Synergetics and the educational process. Moscow: RASS, 8-18.
- Knyazeva, E. N. (2002). Kurdyumov SP Osnovaniya sinergetiki [The bases of synergetics]. *Saint Petersburg*.
- Kodzhaspirova, G. M. (2004). Pedagogy. Moscow: Vldos, 352 p.
- Kolesnikova, I. A. (2014). Transdisciplinary continuing education research strategy. *Continuing education: XXI century*, 4(8), DOI: 10.15393/j5.art.2014.2642
- Kotova, N. A. (2016). The transformation of ideas about the educational environment of the university in the context of different methodological approaches. *Bulletin of the Tambov University. Series Humanities*, 21(1), 33-45.
- Kozyreva, O. A. (2009). Professional pedagogical competence of the teacher: phenomenology concept. *Bulletin of TSPU*, 2, 7-22.
- Miller, B. (2010). Skills for sale: what is being commodified in higher education?. *Journal of Further and Higher Education*, 34(2), 199-206.
- Molchanov V. (2013). On science, religion, system philosophy of Yu. A. Urmantsev, the transpersonal psychology of S. Grof and the formation of a new ideological paradigm. *Ethical and Philosophical Journal "The Edge of the Era."* No. 53. URL: <http://grani.agni-age.net/articles12/4806.htm> (accessed on 08.12.14).
- Panina, S., Tulasynova, N., & Gotovtseva, N. (2016). Developing value paradigm of rising educators at university/ 3rd international scientific conferences on Social sciences & Arts SGEM 2016 24-31August,2016 Albena Bulgaria) Serials Publications Social Sciences; Arts and Humanities, 97(11), 187-194.

- Samsonova, M. V. (2009). Improving the educational process of a university based on a competency-based approach. Moscow. 128p.
- Mikhaylova E. I. (ED). (2015). The concept and technology of continuing teacher education in a modern higher educational establishment: monograph. Scientifically. Yakutsk: North-Eastern Federal University Publishing House, 226 p.
- Vlasova, E. Z., Barakhsanova, E. A., Goncharova, S., Aksyutin, P., Kuzin, Z., & Prokopyev, M. S. (2018). Effective adaptive training of students in Russian pedagogical universities to use e-learning technologies. *Education*, 39(23), 10.
- Walton, P. (2015). Digital information and value. *Information*, 6(4), 733-749.
- Zaragoza, F. M. (2017). Globalization, Trends and Drivers of Change. Higher Education in the World 6. Towards a Socially Responsible University: Balancing the Global with the Local. Girona. 53-67.
- Zeichner, K. (2005). Becoming a teacher educator: A personal perspective. *Teaching and teacher education*, 21(2), 117-124.
- Zhidkikh, T. M. (2012). System-synergetic approach as a pedagogical problem [Electronic resource]. Yaroslavl Pedagogical Bulletin. http://vestnik.yspu.org/releases/pedagoka_i_psichologiy/33_2



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MAJOR FACTORS DETERMINING ACCUMULATION OF TOXIC ELEMENTS BY BEES AND HONEY PRODUCTS

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ABSTRACT

This study presents the results of the main factors that determine the accumulation of toxic elements in the body of bees and some honey products. The following tasks were solved: evaluation of the dynamics of the movement of the heavy metals along with the trophic chain soil-plant-body of bee-honey products; clarification of the main mechanism and the main factors determining the accumulation of heavy metals in the body of bees and honey products. Samples of soil, plants, bees, as well as honey products from areas of the Ryazan region in Russia, were investigated by the method of atomic absorption spectrometry to determine heavy metals. It was found that of all honey products the most environmentally friendly product is honey, and propolis, pollen, and bee bread were most polluted. It was established that the maximum purity of honey was determined by its biochemical composition (mainly carbohydrates, which are secreted by secretory cells of nectaries within a few hours) and by careful draining of pollen grains from nectar by an intermediate valve in a honey sac. It was revealed that the main amount of heavy metals accumulated in the body of bees due to intensive consumption of pollen and bee bread for two weeks, contamination of which was hundreds of times higher than that of nectar and honey, as well as during processing of nectar into honey when draining pollen and entering it into the midgut. The level of pollution of honey products was strongly influenced by the remoteness of the family from the source of pollution. The bee, pollen, and propolis can serve as objective indicators of environmental cleanliness of the environment and the content of heavy metals.

Disciplinary: Multidisciplinary (Biology, Ecology/Ecosystem, Environmental Sciences, Agricultural Science, Food Sciences (Nutrition and Toxicity)).

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1. INTRODUCTION

At present, in the age of technical progress, there have been violations in the ecology of the Earth. Human activity often adversely affects the environment. Man ceased to feel himself and the environment as a whole within the biosphere.

We live in the era of paradoxes when with the latest achievements of science and technology, we do not improve our living environment, and often pollute it because of insufficient education and culture, and the lack of objective control. Pollution disturbs ecology.

There is a relationship: bees, their environment and the man (the beekeeper). When normal living conditions, humans and vegetation, insects and animals develop normally under the influence of a system or combination of environmental factors. Under their influence, nature forms an organic whole. Ecological distress affects the health of humans and animals. Harmful substances from the environment, entering the body, accumulate in the tissues, aggravate cell metabolism and pollute the internal environment.

One views honey products as ecologically clean when during their production cycle adopted for various stages they correspond to established organoleptic, hygienic, technological and toxicological standards and do not adversely affect the health of men and animals and the environment (Lebedev, 2016).

Contamination of honey products with various substances is due to a multitude of interrelated processes occurring with varying intensity in the interfaced environments and components of the ecosystem.

The unique properties of honey products that have been tested by more than one generation and received a special significance in our age of environmental tension and high-stress loads contribute to the growing interest in them. Honey products are not just natural. They are able to change the functional state of the physiological systems of the human body in fairly low concentrations. By chemical composition, these products are, as a rule, a composition of biologically valuable compounds that are completely absorbed by the body.

Honey products have a wide range of biological properties and a positive physiological effect, synergistic to the human body. To reduce the negative impact of the environment on human health, it is necessary to improve the quality of nutrition and the use of ecologically pure honey products. This is one of the priority ways to solve this problem. And one of the main conditions for obtaining pure honey products is the search for environmentally friendly places of their production.

The degree of pollution by toxicants, as a rule, is determined by analyzing their content in the soil, water, and air, which is associated with significant labor and time costs, but the biotic component of ecosystems remains beyond researchers' attention. When monitoring ecosystems, biological methods that imply the use of honey bees, being common and very sensitive to environmental pollution, are very promising. In this connection, detailed studies of the properties of the indicators are necessary, which allow determining the extent to which bees and their products reflect the state of the ecosystem, as well as tracing the migration of heavy metals along trophic chains, where insects (bees, in particular) are an important link.

Monitoring (from Latin 'monitor' is the one who reminds, warns) implies monitoring of some phenomena, complex observation, and assessment of changes and the state of the biosphere or its individual elements (Efimenko, 2012).

Many researchers are working on the problem of obtaining ecologically pure honey products.

Unfortunately, in our country, there is no reliable and accessible information on the contamination of specific areas of agricultural land with these or those harmful technogenic substances (Burmistrova, 2008).

Environmental pollution with heavy metals has pronounced mutagenic and carcinogenic effects, causing poisoning (often fatal) and disruption of various physiological functions of the body. Therefore, studies of the migration of heavy metals in the biosphere, their movement along trophic chains as well as studies of the mechanisms of entry, accumulation, and utilization in biological objects are very important. Of particular importance are such studies in regions with a developed metallurgical and chemical industry, where the background level of heavy metals in the environment is elevated (Kharitonova, 2015).

Heavy metals belong to the group of substances potentially hazardous to human health. By hazard level chemical elements are divided into three classes:

- 1) highly hazardous substances - arsenic, cadmium, mercury, lead, zinc;
- 2) moderately hazardous substances - copper, molybdenum, chromium, tin;
- 3) low hazardous substances - tungsten, barium, strontium, manganese (John, 2009).

The most dangerous to the biosphere heavy metals include cadmium, nickel, mercury, lead, chromium, copper. Chronic exposure to low doses of toxic substances, like low levels of radioactivity, can cause impaired metabolic processes, immunological status, neurohumoral systems, hereditary properties, etc. (Yagin, 2013).

Lead, mercury, and cadmium, which accumulate in the soil, are absorbed by the roots of plants and along trophic chains enter animal and human organisms. To reduce the concentration of toxicants various preparations that have sorption, ion-exchange and biologically active properties are used. In an organized system of agrotechnical measures, liming and the application of organic fertilizers are used to reduce the mobility of heavy metals and their entry into the plant. Evaluation of the effectiveness of these and other recreational activities, as well as an assessment of the degree of increasing environmental pollution, requires a reliable monitoring system (Eskov, 2012).

Kolbina (2000) analyzed the dynamics of the movement of iron, copper, manganese, and zinc in the system “soil — honey plants — bees — honey, wax, propolis” on the territory of Udmurtia. It has been established that the concentration of heavy metals in plants may increase (zinc) or decrease (iron, manganese, copper) in relation to their content in the soil. The concentration of these elements in the body of bees was higher than in plant tissues. However, the level of heavy metals in honey and wax was significantly lower than in the tissues of bees and did not exceed the MAC, which allowed speaking about the filtering ability of bees. The studies helped to identify both the territories most contaminated with these metals and relatively clean and to conclude that bees and their products can be used in a comprehensive assessment of the environment as an additional information channel of the monitoring system (Kolbina, 2000).

The main sources of heavy metals in the soil are natural parent rock materials. But it should be taken into account that recently, technogenic human activity, which leads to drastic changes in the environment, through pollution with industrial waste (fluorine, sulfur, arsenic, lead, etc.) affects the content of heavy metals in the soil to a far greater degree (Puhalskiy, 2017).

With a high content of pollutants in the soil, they begin to accumulate in plants in excess and migrate along the food chain to the body of bees and, further, through honey products come to the

consumer, causing chronic poisoning and other serious diseases. It is unacceptable to have an apiary near highways and industrial facilities since there is a high probability of toxic elements entering the honey products. It is established that the remoteness of the apiary from the source of pollution has a significant impact on the level of pollution of honey products (Rusakova, 2006; Dubovik, 2011).

Most of the toxic substances that pollute the soil, accumulate in its upper 5-cm layer and then enter the plant. When passing through trophic chains, some substances dissipate, while others accumulate. Concentration and accumulation of toxic substances in this chain are characteristic mainly of radionuclides, heavy metals, and some pesticides that are resistant to decay. Therefore, relatively low concentrations of substances in the soil can become dangerous for humans when moving along food chains from plants to bees and then through honey products to their consumers (Murashova, 2016).

It has been established that the content of heavy metals in entomophilous plants may increase or decrease with respect to their content in the soil (Kovalchuk, 2014).

It is known that plants accumulate heavy metals not only from the soil but also from the air. That is why their concentration in plants may exceed or be lower than the content in the soil. Leaf vegetable absorbs especially much lead from the air, up to about 95 %. With increased soil pollution by lead (about 50 mg/kg), herbaceous honey plants accumulate about a tenth of this amount. And they actively absorb zinc. The amount of this element in them can be several times greater than its content in the soil. Herbaceous plants of natural biocenoses have the greatest ability to concentrate heavy metals. Morpho-physiological features of plants in natural lands have more favorable factors for the root entry of pollutants compared to agrocenoses. On arable cultivated lands, radionuclides and heavy metals are distributed over the arable horizon more evenly, and, consequently, reduce their entry into agricultural crops from 2-5 times. The introduction of potash fertilizer also reduces the amount of toxic elements in the soil. Accordingly, the content of heavy metals in fodder crops on arable land is much lower than in natural biocenoses (Eskov, 2001; Sokolskiy, 2012; Kharitonova, 2015).

It has been established that pollutants of the food consumed by bees accumulate mainly in their rectums (Eskov, 2012).

Bees are constantly affected by a variety of factors, especially when pollinating entomophilous plants and collecting nectar. Other important factors include humidity and ambient temperature, solar radiation, wind, the state of nectar and pollen sources (Fatkullin, 2017).

A particular threat to the purity of products of bee colonies is caused by environmental pollution by road transport and industrial enterprises for various purposes. Bees infect themselves and produce polluted, hazardous products, collecting nectar and pollen from honey plants infected with toxic substances (Yadav, 2010).

The quality of bee products depends on a variety of conditions. It is extremely important to comply with the technological requirements during their production, storage, and transportation. The most important condition is the proper placement of the apiary taking into account the environment: field pollution with pesticides, taking into account the sanitary condition of apiaries, the health of bee colonies and the use of various preventive and therapeutic means (Osintseva, 2008).

Honey products obtained along highways are prone to lead contamination. Many authors have noted that lead is not transported by plants and can get into honey products, mainly from the atmosphere through direct contact with nectar and pollen. The most important sources of cadmium for honey products are the metallurgical industry and atmospheric pollution caused by burning

household and industrial wastes. Cadmium is also transported by plants from the soil and only a small part of cadmium can get into honey and other honey products from the atmosphere, this happens mainly if the apiary is located in the immediate vicinity of refuse incinerators (Jose, 2009; Nanti Bolan, 2014).

When certification and standardization of honey products problems that are associated with a variety of collection conditions and, as a consequence, their chemical composition often appear.

Among other constituent elements determining the safety and therapeutic value of such products, there may be heavy metals with a relative atomic mass of more than 40, or density of 5 g/cm³ according to the technical classification. This group includes toxic metals (cadmium, lead) and trace elements that have physiological and biochemical significance (zinc, copper). Research works in recent decades in the field of environmental monitoring have shown that honey products, like bees, are indicators of pollutant accumulation in biocenoses (Murashova, 2004; Lebedev & Murashova, 2016; Eskov, 2016).

The main argument in favor of using bees in bioecological monitoring is that bees actively collect nectar and pollen in a radius of about 3 km. However, there are certain limitations. Namely, bees form their food reserves only when, under favorable weather conditions, entomophilous plants secrete nectar and produce pollen. Most often this happens only on an apiary part. Honey plants are blooming for a short time, from several days to several weeks, and therefore the bee family does not have the opportunity to replenish feedstocks for most of the annual cycle. Thus, environmental monitoring with the help of bees will be fragmentary both in time and in space (Osintseva, 2015).

In this regard, the use of trophic motivation of bees focused on the replenishment of feedstocks is significantly limited by this fact (Dimou, 2007).

A lot of information indicates the concentration of heavy metals in the system “water - soil - plants - bees - honey products”, but data on their content in various honey products are contradictory (Rusakova, 2006).

All over the world, the requirements for environmental cleanliness of honey products are getting stringent. In our country, sanitary and hygienic requirements for food products (SanPiN 2.3.2. 1078-01) normalize the amount of lead, arsenic, and cadmium for natural honey, pollen and dietary supplements based on honey products, as well as the concentration of mercury for pollen and dietary supplements based on it (Kharitonova, 2015).

However, it should be noted that in this regulatory document there are no requirements for wax that are in direct contact with honey and other honey products. Specific features of honey products are not taken into account, and requirements for the content of copper and zinc are not limited (Efimenko, 2012).

Since they serve as components of the mineral composition of all honey products, it is very important to establish the dependence of the quantitative content of these elements on environmental conditions. In our country, environmental studies have started relatively recently, but it is already possible to talk about the feasibility of using bees in bioecological monitoring. The tissues of the organs of bees, honey, bee-bread, pollen and propolis, in which radioactive nuclides, pesticides, heavy metals, and other toxic substances are concentrated, provide information about environmental pollution (Dzhambulov, 2010).

Studies show that environmental pollution by toxic elements significantly affects the purity of

propolis and pollen, and in honey and wax, these substances do not accumulate. The highest content of copper and zinc in the body of the bee indicates the accumulation of these elements by them. The unique structure of the body of the bee, its physiological characteristics allow it to concentrate in its body a significant portion of heavy metals and other toxic elements. This is due to the special permeability of the walls of the honey sac. Together with the water that is absorbed by the hemolymph from the content of the honey sac through its walls, toxic substances also pass through. They accumulate partially in the fat body and partially in other structures of the bee's body. Some of them are removed by excretory organs (Ai-Rashdi, 2013).

Significantly increased levels of some toxic elements in bees, soil, plants, as compared to honey, wax and royal jelly indicate that bees produce environmentally friendly products due to their vital activity. According to statistics, the content of heavy metals in forest honey is higher than in floral honey (Suresh Kumar, 2015).

Together with nectar, honeydew, pollen, and water, they are brought into the hive, getting into honey, propolis, wax, and pollen (Fatkullin, 2017).

It is important that food products, including honey products, are environmentally friendly. Consequently, it is necessary to control the content of heavy metals in products of general consumption systematically and carefully. In addition, the certification of food products, raw materials, and honey products also provides for their safety parameters, for which they establish the maximum allowable concentration (MAC) of the content of toxic elements, radionuclides, and pesticides (Eskov, 2016).

Honey, as a natural product, has no equivalents in the number of ash elements. About forty macro- and microelements are found in it, however, their set and relative content are subject to considerable fluctuations depending on the origin of this product. Thus, the values for magnesium, lead, copper and some other elements differ 100-500 times, and for tin and zinc - 900-2,000 times. Honey contains relatively much potassium, calcium, sulfur, and magnesium. Copper, zinc, aluminum, cobalt, nickel, etc. have also been found in it. The amount and composition of minerals in honey depends on their geographical and botanical origin.

Foreign researchers argue that the content of heavy metals depends on their presence in nectar. The latter fact is, in turn, affected, among other reasons, by the type of flower (male or female), its age, location on the plant and the structure of nectaries. The amount of metals contained in the honey from various plants varies widely. However, in all cases, there are more metals in polyfloral honey than in monofloral ones.

Bulgarian researchers give some data on the content of heavy metals in the honey of various botanical origin (Table 1).

Table 1. The content of some chemical elements in various types of honey (mg/kg).

Type of honey	Number of samples	Tin M±m	Cadmium M±m	Copper M±m	Zinc M±m	Iron M±m
Acacia	41	0.07±0.03	0.007±0.002	0.14±0.04	0.84±0.28	11.5±5.1
Polyfloral	75	0.08±0.03	0.008±0.003	0.20±0.07	0.86±0.31	18.1±5.1
Honeydew	13	0.08±0.03	0.004±0.001	0.34±0.05	1.13±0.51	20.6±7.3

It can be seen from the table that tin and cadmium are close in values in different types of honey. Cadmium content in honeydew honey is lower than in other types of honey - acacia and polyfloral. According to the authors, these elements are background pollutants of honey and get into it,

regardless of the season and the type of honey plants. There is significantly more copper, zinc and iron in honeydew than in acacia and polyfloral honey (Burmistrova, 2008).

The results of the spectral analysis of samples of domestic honey for the presence of various elements in them indicate a wide range of chemical elements in the presented honey samples. Of the 16 elements studied, no samples have lead, tin, nickel, cobalt. Silver is present in only one of 10 samples, and potassium in two. The remaining elements are contained in honey, which indicates its multi-component mineral composition, as well as the nutritional properties of honey. Of heavy metals, copper is found in almost all samples and lead, as mentioned above, is absent. Arsenic and cadmium cannot be determined (Rusakova, 2006).

In addition to the natural content of metals in honey, their number is also influenced by grown honey plants. Deforestation, the expansion of areas under wind-pollinated crops, the chemicalization of agriculture, the increase in toxic emissions by industrial enterprises and radioactive contamination create prerequisites for substances in honey harmful to people's health.

A bee's nest gives a wide and unique range of environmental characteristics during its active state. The bee, collecting nectar, pollen from flowers and resinous substances within a radius of 3-5 km from the apiary, naturally transfers all substances that pollute the environment into the products of its vital activity: honey, pollen, bee bread, royal jelly, propolis, thus testifying local contaminated areas. In addition, the bee population itself, when metabolizing these products, can act as an integrating indicator of the state of the environment.

Currently, the mineral composition of bees, honey, and pollen collected by bees is considered as an indicator of the presence of some metals in this zone.

In recent years, many publications have appeared on the relationship between the bees, the products they produce and the traces of metals in their environment. It is noted that honey collected near large industrial enterprises and highways contains much more lead than that collected far from them (Rusakova, 2006).

Honey and bees from apiaries located near a zinc smelting plant in Poland were contaminated with zinc, cadmium, and lead. At the same time, lead was found in corpses of bees more often than its natural content by 5-7 times, zinc and cadmium by 3.5 times, and the honey contained less lead by 100 times, zinc by 5 and cadmium 10 times than the bees. This indicated the influence of the environment on bees and their products, as well as the fact that bees effectively delayed the entry of heavy metals into honey, even due to their own death.

In another paper, Polish researchers indicated that samples of honey obtained far from the highway showed a very low content of iron, zinc, magnesium, copper, nickel, lead, cadmium and cobalt. Similar data were obtained in the United States. The lead content in flowers and bees in the area of the busy highway was more than 20 times higher than 850 m from it. It is obvious that it is impossible to keep bees in cities and subsidiary farms located near large factories, highways, and airfields (Burmistrova, 2008).

Due to the fact that this condition is often violated, systematic careful control of honey and other honey products to determine heavy metals is necessary.

Hygienic requirements for the safety of food raw materials and food quality, approved in 1996, set standards for the content of only two toxic elements in honey: lead (no more than 1.0 mg/kg) and cadmium (no more than 0.05 mg/kg). These requirements are not documented for wax, although this

product is in direct contact with honey and is widely used in the perfumery and pharmaceutical industry (Dubovik, 2011).

Determining copper and zinc is not provided for by sanitary requirements, while these elements can penetrate into honey products from both the equipment they come into contact with and the environment (Rusakova, 2006).

Due to contradictory data on the effect of various polluting factors on the ecological purity and safety of honey products, this issue requires particularly careful study.

Taking into account the above, the aim of these investigations was to study the basic mechanisms and factors that determine the accumulation of toxic elements in the body of bees and some honey products in the conditions of the Ryazan region.

- to evaluate the dynamics of heavy metals movement along the trophic chain: soil-plant-body of a bee - honey products;
- to find out the main mechanism and the main factors that determine the accumulation of heavy metals by bees and some honey products.

2. MATERIALS AND METHODS

The main experimental part of the work was done in the apiaries of the Ryazan region, in laboratories of FSBRI “Federal Research Center for Beekeeping” and its basic enterprises during a two-year period.

The objects of research were samples of soil, plants, and honey products, such as honey, pollen, bee bread, wax, propolis and royal jelly, which were selected from different areas of the Ryazan region.

Samples of honey, pollen, royal jelly, wax, and propolis were collected in apiaries when preparing samples of soil, plants and bees.

The soil, plants, and bees were pre-dried and then mineralized. When preparing the samples of wax, the acid extraction method was used. In the case of propolis sampling, the dry ashing method was used. Samples of honey, pollen and royal jelly were prepared by dissolving using an ultrasonic homogenizer.

Honey samples were investigated by atomic absorption spectrometry to determine lead, cadmium, copper, zinc, mercury and arsenic in the laboratory (spectrophotometer Specter AA 220 FS of the company “Varian”) on the basis of FSBRI “Federal Research Center for Beekeeping”.

Experimental and control groups were formed by the method of selection of pairs of bee families-analogs of the Priokskiyinterbreed type of the Central Russian breed of bees.

Based on the obtained data, the results were analyzed. Then tables and graphs were made, which presented the information on the quantitative content of toxic substances in the analyzed samples of soil, plants, bees, honey, and other honey products.

3. RESULTS AND DISCUSSION

An analysis of the experimental data obtained over two years has shown that the concentration of heavy metals in the recorded bee plants is significantly reduced compared with their content in the soil. At the soil-plant stage, a decrease in copper concentration by 2.8 times, zinc by 1.6 times, cadmium by 1.3 times, and lead by more than 20 times has been found. Differences in all cases are highly reliable (Table 2).

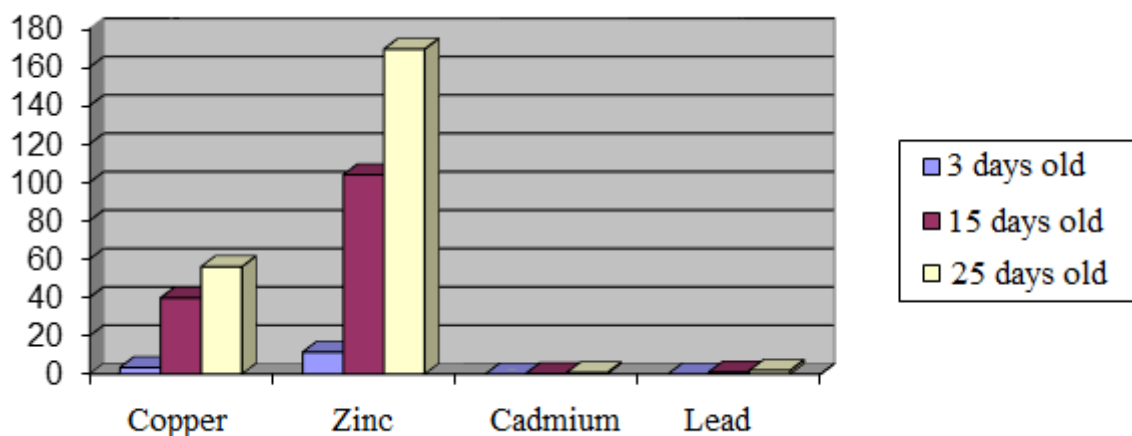
Table 2. The content of heavy metals in honey products, mg/kg

Object to be examined	Zinc	Copper	Lead	Cadmium	Arsenic	Mercury
Soil	29.5	12.2	9.81	2.40	0.18	-
Plants	18.75	4.33	0.45	1.91	-	-
Bee's body	49.1	15.0	0.47	0.19	-	-
Pollen	18.9	5.2	0.48	0.09	0.34	-
Propolis	59.1	5.0	2.26	0.78	-	-
Bee bread	14.6	4.3	0.25	0.07	-	-
Royal jelly	6.38	3.10	2.8	-	0.02	-
Wax	0.78	0.57	0.18	0.007	-	-
Honey	0.32	0.35	0.09	0.04	-	-

Based on the data in Table 2, it is possible to judge the dependence of the content of toxic elements in honey products on their presence in environmental objects. The most intensive migration from soil to plants was observed in zinc and copper.

When clarifying the mechanism of accumulation of heavy metals in the body of bees, three groups of 5 nucleus families each were formed, which were placed in separate sections of the ward. Young laying queens, derived from the same maternal family, were introduced into the formed families. The nucleus families were formed from an equal number of young bees (3-5 days old, obtained in wards and mixed together), that is, equalized in physiological state and origin.

In the course of investigations, it was found that the content of heavy metals in the body of bees increases quite naturally with an increase in their age (Figure 1), that is, they accumulate during the life of bees in their bodies. No lead, mercury, cadmium, and arsenic were found in the body of young (three-days old) bees, while the zinc and copper content was significantly lower than in plants (11.45 and 3.41 mg/kg, respectively).

**Figure 1.** The accumulation of heavy metals in the body of bees, depending on their age, mg / kg

A rather sharp increase in the content of heavy metals occurs in the body of bees in the first two weeks of life, that is when they perform a cycle of intra-hive work (mainly broods are grown and honeycombs are built). At this age, the zinc content is 9.1 and 11.6 times more than in the body of young bees. At the same age, lead and cadmium are found in the bees. The transition to the function of collecting nectar and pollen leads to an increase in the content of heavy metals in the body of bees, but

not so dramatically. Thus, the content of zinc and copper increases in bees at the age of 25 days, but only by 63 and 41 %, respectively, compared to the content of these elements in bees from the same families at the age of 15 days. At the same age, bees have the maximum content of lead and cadmium in their bodies (1.9 and 0.73 mg/kg, respectively).

Feeding bees for 20 days with sugar syrup did not lead to significant changes in the content of the studied metals in their bodies. All fluctuations were within the accuracy of the measurement of these parameters. Keeping bees on a protein-free diet for twenty days led to their almost complete death. During this period, they grew 14 times less brood than bees from families that had honey and pollen.

There was no significant increase in the content of heavy metals in the body of the bees, fed with pure honey for 20 days. The lifetime of bees in this group of nuclei was significantly higher than that of bees in sugar syrup, but at the same time, they grew brood 4.3 times less during this time than bees from families that ate both honey and pollen.

When young bees consumed a larger amount of protein feed (bee bread), there was a significant increase in heavy metals in their bodies. Thus, the zinc content for 20 days of feeding bees with bee bread increased by 12.3 times and that of copper by 14.2 times, compared with the amount of the same metals in bodies of 3-5-days old bees. Arsenic, cadmium and mercury were not found in bees, and the lead content increased from zero to 1.5 mg/kg for 20 days of feeding the bees with bee bread.

From the studied honey products: honey, wax, pollen, bee bread, propolis, and royal jelly, honey and wax contained the smallest amount of the heavy metals (Table 2).

Due to the fact that the requirements of SanPiN 2.3.2. 1078-01 do not have standards for the content of heavy metals for wax, we relied on their MAC in honey, when analyzing the data on the content of toxic elements in wax. All values of the content of elements for the studied period of time were within the normal range.

The content of elements in soil samples can be associated with both soil-forming rocks and the influence of anthropogenic factors. In this case, soil contamination with heavy metals, such as lead and zinc, can be triggered by being close to the apiary of the road and railway. Despite the fact that initially, the content of toxic elements in soil samples exceeded the MAC, in almost all honey products, except for propolis and pollen, the concentrations of heavy metals were within the normal range.

The maximum content of toxic elements was noted in the soil, propolis, pollen and the minimum one - in honey.

The content of zinc, copper, and lead in the honey samples was significantly less than in propolis, pollen, the body of bees, plants and soil. So, the zinc content in honey was less than in bees from the same families by almost 153 times, copper - by 42.9 times, cadmium - by 4.8 times and lead - by 5.2 times.

Significant differences in the level of heavy metals in such honey products as honey, pollen, and propolis are determined primarily by their biochemical composition, processes of formation and mechanisms of processing by bees.

Glucose, fructose, and sucrose predominate in the nectar of plants. For the secretion of nectar plants form carbohydrates, which are supplied to the nectaries and used, while absorbing carbon dioxide from the air, water from the soil, and also using solar energy. It should also be remembered that a portion of nectar collected by a bee is formed (secreted) for the very several hours.

It is the above that determines the minimum content of heavy metals in nectar as compared to

pollen, which is formed during a few days from completely different components (lipids, proteins, carbohydrates, etc.).

The content of heavy metals in the nectar selected from honey sacs was 2,500-3,000 times less than in the pollen pellet collected by bees from the same families.

Significant differences were found in the content of lead in the nectar from the honey sacs and the honey prepared from it. So the lead content in the nectar introduced by bees into the hive averaged 0.69 ± 0.033 mg/kg, and its content in the honey from the same family was 0.43 ± 0.057 mg/kg. The identified differences are significant ($P = 0.99$). Apparently, these differences, determined by the fact that the bees processing nectar into honey, drain by the intermediate valve in the honey sac a significant amount of pollen grains from nectar, and the content of heavy metals in these pollen grains are much higher than in honey.

A significant reduction in the amount of heavy metals in mature honey is provided precisely by reducing the content of pollen grains in it.

For the two-year period of investigations according to the results of the analysis of the content of toxic elements in honey samples, there have been no cases of exceeding the MAC of toxic elements. In addition, no residual mercury has been detected in honey samples.

As a result of the analysis of propolis samples for the content of heavy metals in them, the MAC of lead is found to be 2.26 mg/kg at a rate of 1.00. The concentration of heavy metals in propolis may be the same as in soil and plants, and in some cases even higher. This is due to the fact that their entry into propolis comes from the soil in the process of extracting resinous substances by plants, which takes quite a long time. Along with this, they can accumulate volatile substances from the air.

Analysis of the results of the study on the content of heavy metals in royal jelly samples has shown that the samples revealed an excess of the allowable lead content by a factor of 1.8 mg/kg.

The remoteness of the family from the source of pollution has a strong influence on the level of pollution of honey products. To study this factor, we had a special experiment.

The pollen pellet collected by bees mainly from dandelions, growing in the area of the large busy highway of federal significance M5 "Ural" (Moscow-Chelyabinsk) was investigated. One experimental group of families was located 150 m from the highway, the other one was about 1,000 m from it. There were 5 families of analogs in each group. From selected samples of the pellet collected by bees from experimental families, the pollen was separated mechanically (by color) and analyzed for the lead content. This was the pollen from only one type of dandelion plant growing at a different distance from the highway.

It was found that the lead content in the pollen collected by bee families located 150 m from the highway averaged 1.56 ± 0.03 mg/kg, and the pollen of the same plant species, but selected by bee families that were at a distance of about 1,000 m, had only 0.03 ± 0.0067 mg/kg, which was 52 times less (the difference is highly reliable $P > 0.999$). After 10 days of the experiment, samples of bees returning from the field with the pollen pellet were taken, and the lead content was determined.

In terms of the lead content in the body of bees from the experimental families, significant differences were established - 3.22 ± 0.092 and 0.21 ± 0.017 mg/kg, respectively (the differences were highly significant $P > 0.999$). Thus, the lead content in the body of bees collecting pollen is highly significantly increased (accumulated), which can be clearly seen from the experimental data obtained.

Of all the honey products, honey is the most environmentally friendly product, and propolis, pollen, and bee bread are the most polluted ones. The investigations make possible to make such a conclusion.

It was established that the maximum purity of honey was determined by its biochemical composition (mainly carbohydrates, which are secreted by secretory cells of nectaries within a few hours) and by careful draining of pollen grains from nectar by an intermediate valve in a honey sac.

It was revealed that the main amount of heavy metals was accumulated in the body of bees due to intensive two-week consumption of pollen and bee bread contaminated hundreds of times more than nectar and honey, as well as when processing the nectar into honey while the pollen filtering and getting into the midgut.

It is necessary to select ecologically clean areas when receiving pollen and bee bread especially carefully. For the production of pollen and bee bread, it is impossible to place bee families closer than 1,000 m from major highways, as this will lead to an unacceptable level of lead content in these products.

The bee, pollen, and propolis can serve as objective indicators of environmental cleanliness and the content of heavy metals.

4. CONCLUSION

It has been established that at the soil-plant stage, the concentration of copper decreases 2.8 times, zinc 1.6 times, cadmium 1.3 times, and lead more than 20 times. The differences in all cases were highly reliable.

It has been established that the content of heavy metals in the body of bees naturally increases with an increase in their age. No lead, mercury, cadmium, and arsenic have been found in the body of young (three-day) bees, while the zinc and copper content is significantly lower than in plants (11.45 and 3.41 mg/kg, respectively).

It has been revealed that the consumption of a greater amount of protein feed (bee bread) by young bees leads to a highly significant increase of heavy metals in their bodies. Bee bread nutrition for 20 days resulted in an increase in the zinc content by 12.3 and copper by 14.2 times as compared with the level of these metals in the body of 3-5 day bees. Arsenic, cadmium, and mercury have not been recorded in the body of the bees, and the lead content for 20 days of bee bread nutrition has increased from zero to 1.5 mg/kg.

The zinc content in honey is less than in bees from the same families by almost 153 times, copper by 42.9 times, cadmium by 4.8 times and lead by 5.2 times. Propolis and pollen contain the greatest amount of heavy metals from all honey products.

The maximum purity of honey is determined by its biochemical composition and by careful filtering of pollen grains from nectar through an intermediate valve in a honey sac. So the lead content in nectar is 1.6 times more than in honey from the same family.

The lead content of pollen collected by bee colonies 150 m from the highway is 52 times higher than that of the same plant species but selected by families about 1,000 m away. Differences in lead content in the bee body from experimental families are also significant - 15.3 times.

Thus, the use of bees and honey products as environmental indicators will improve standardization methods aimed at improving the quality of honey products. The obtained data can be taken as a guide when planning the placement of beekeeping in certain regions of the country, as well

as providing some objective evaluation of the environmental situation. Bees and their products such as pollen pellet and propolis can be recommended as objects for monitoring the cleanliness of the environment and the content of heavy metals in it.

4. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

5. REFERENCES

- [1] Al-Rashdi, B. A. M., Johnson, D. J., & Hilal, N. (2013). Removal of heavy metal ions by nanofiltration. *Desalination*, 315, 2-17.
- [2] Bolan, N., Kunhikrishnan, A., Thangarajan, R., Kumpiene, J., Park, J., Makino, T. & Scheckel, K. (2014). Remediation of heavy metal (loid) s contaminated soils—to mobilize or to immobilize?. *Journal of hazardous materials*, 266, 141-166.
- [3] Burmistrova, L.A., Rusakova, T.M., Lizunova, A.S., Repnikova, L.V. (2008). Peculiarities of accumulation of toxic elements in individual honey products. *Modern technologies of honey production and processing*. Materials of Int. sc.-pract. conf. on beekeeping, Novosibirsk, 13-19.
- [4] Dimou, M., & Thrasylvoulou, A. (2007). A comparison of three methods for assessing the relative abundance of pollen resources collected by honey bee colonies. *Journal of Apicultural Research*, 46(3), 144-148.
- [5] Dubovik, V.A. (2011). Soil pollution with heavy metals and radionuclides: monitoring and techniques for reducing ecotoxicity. *Agricultural Biology*, 6, 27-36.
- [6] Dzhambulatov, M.M., Magomedaliev, Z.G., Magomedaliev, A.Z. and Aliev, A.A. (2010). On zinc provision for fodder vegetation in the plain-like zone of the Republic of Dagestan. *Agricultural Biology*, 4, 95-100.
- [7] Efimenko, A.A. and Moreva, L.Ya. (2012). Selective ability of honey plants to accumulate heavy metals and radionuclides. *Beekeeping*, 10, 6-7.
- [8] Eskov, E.K., Eskova, M.D. and Vyrodov, I.V. (2012). Migration of heavy metals in the system soil - honey plants - the body of a bee - honey products. *Agrochemistry*, 9, 78-83.
- [9] Fatkullin, R.R. and Gazitulina, Yu.A. (2017). Heavy metals in the food chain "soil-plant - bee body - honey products" as indicators of the environment. *News of Orenburg State Agrarian University*, 1, 271-273.
- [10] John, R., Ahmad, P., Gadgil, K., & Sharma, S. (2012). Heavy metal toxicity: Effect on plant growth, biochemical parameters and metal accumulation by Brassica juncea L. *International Journal of Plant Production*, 3(3), 65-76.
- [11] Kharitonova, M.N., Burmistrova, L.A., Esenkina, S.N., Vakhonina, E.A., Martynova, V.M. and Sedova, G.A. (2015). Studies of the content of toxic elements in honey products and bee bodies. *Herald of Ryazan State Agrotechnological University Named after P.A. Kostychev*, 3, 47-48.
- [12] Kolbina, L.M. (2000). *Pollution of honey products by heavy metals in Udmurtia*. Issues of apidology and beekeeping. Izhevsk, US - RIA RAAS, 67-75.
- [13] Kumar, K. S., Dahms, H. U., Won, E. J., Lee, J. S., & Shin, K. H. (2015). Microalgae—A promising tool for heavy metal remediation. *Ecotoxicology and environmental safety*, 113, 329-352.
- [14] Lebedev, V.I. and Murashova, E.A. (2016). The influence of the main factors on the quality of honey. *Coll. of materials of the 4th Intern. Sc. and Pract. Conf. Beekeeping of Cold and Temperate Climate*, Pskov, 2-3 September 2016, Moscow, 43-47.

- [15] Li, Z., Ma, Z., van der Kuijp, T. J., Yuan, Z., & Huang, L. (2014). A review of soil heavy metal pollution from mines in China: pollution and health risk assessment. *Science of the total environment*, 468, 843-853.
- [16] Murashova, E.A. (2004). *Biotechnological aspects of the production of environmentally friendly products of beekeeping*. Dis. Cand. of Agr. Sc., Ryazan.
- [17] Osintseva, L.A., (2008). Comparative evaluation of honey products on the content of heavy metals. *Bulletin of the Russian Academy of Agricultural Science*, 2, 88-90.
- [18] Pashayan, S.A. (2006). Migration properties of heavy metals. *Beekeeping*, 9, 12-13.
- [19] Peralta-Videa, J. R., Lopez, M. L., Narayan, M., Saupe, G., & Gardea-Torresdey, J. (2009). The biochemistry of environmental heavy metal uptake by plants: implications for the food chain. *The international journal of biochemistry & cell biology*, 41(8-9), 1665-1677.
- [20] Pukhalskiy, Ya.V., Vishnyakova, M.A., Loskutov, S.I., Semenova, E.V., Saxte, E.A., Shaposhnikov, A.I., Safronova, V.I., Belikov, A.A. and Tikhonovich, N.A. (2017). Pea (*Pisum Sativum*) varieties with low accumulation of heavy metals from polluted soil. *Agricultural Biology*, 3(52), 597-606.
- [21] Shchur A.V., Valkho V., Vinogradov D., Valko V. (2017). Influence of biologically active preparations on caesium-137 transition to plants from soil on the territories contaminated after chernobyl accident. *Impact of Cesium on Plants and the Environment Switzerland*, 51-70.
- [22] Yadav, S.K. (2010). Heavy metals toxicity in plants: An overview on the role of glutathione and phytochelatins in heavy metal stress tolerance of plants. *South African J. of Botany*, 2, 167-179.
- [23] Yagin, V.V., Gladyshev, O.S. and Khomutov, D.A. (2013). Effect of heavy metals on food mobilization of bees. *Herald of Nizhniy Novgorod University Named after N.I. Lobachevskiy*, 6(1), 129-132.



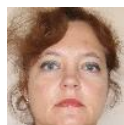
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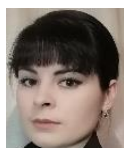
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EFFECTS OF CHINA PAKISTAN ECONOMIC CORRIDOR ON REGIONAL INTEGRATION AND ECONOMIC GROWTH

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ABSTRACT

The Sino-Pakistan Agreement on China Pakistan Economic Corridor (CPEC) is a combination of infrastructure and energy projects worth \$62 billion as of 2018 for economic development and regional integration. The potential and significant projects of CPEC intend to develop the landscape of regional integration by constructing interconnected infrastructure projects. This agreement envisions restructuring and transforming the local connectivity of the states of China, Pakistan, Iran, Afghanistan, India, and CARs. This study emphasizes to argue and examine the likely impacts of CPEC projects on regional integration, specifically for enhancing the economic ties among the states. The "Neo-Functionalism Theory" deems fit to analyze the potential plans of CPEC for achieving regional integration and economic growth.

Disciplinary: International Economics and Political Sciences
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1. INTRODUCTION

In recent years, regional integration is a promising and beneficial strategy between states for promoting steady economic growth, connectivity, macroeconomic cooperation, and maintaining peace through standard rules and institutions. Regional integration and development is a multidimensional concept. However, critical ascription and features are economic development, growth, and trade integration (Shoukat et al., 2017). The CPEC is a combination of energy and infrastructure projects worth \$62 billion as of 2018 for economic development, and regional integration, which is under construction throughout Pakistan. The projects of CPEC are supposed to

develop economic zones, industrial parks, dams, energy development, and education schemes by linking these regions with well-run highways and railway tracks through the Kashgar-Gwadar route bisecting all Pakistan. Wolf (2016) contends that the projects of CPEC originate in reshaping the bilateral trade and energy agreements between the two states of Pakistan and China. The CPEC emphasizes to provide a platform of regional connectivity, business opportunities, and economic development in the adjacent areas and the rest of the world (Wolf, 2016).

This research article aims to show the logical action of the significant and powerful forces influencing the integration process and thoughts to examine the effects of CPEC on Pakistan's relations with neighboring countries, regional integration, and geo-economic evolution. This article hypothesized the statement that Pakistan and China are progressively joining a venture of geo-economic through CPEC projects. The Chinese president, Xi Jinping, officially visited Pakistan on April 20, 2015, to signed and initiate the CPEC agreements to enhancing the economic cooperation with Pakistan and across the region. The two states signed the CPEC project to strengthen regional integration and economic growth by interlinking the regional countries such as China, Pakistan, Iran, Afghanistan, India, and CARs (Central Asian Republics). Safitri (2016) reports that foreign policy strategies are incorporating the concept of economic-corridors, and it has become the buzzword in economic plans to stimulate the economic growth by deepening the regional integration in Asia's sub-regions (Safitri, 2016). South Asia (SA) region has great potential to accelerate economic growth; however, SA remained underdeveloped and least integrated. The region of SA has abundant natural resources; yet, it has challenges of the energy crisis, which is affecting the economy severely.

The analysis of this article drawn attention to an exhaustive of primary and secondary sources materials. The materials precisely comprise of, interviews, decision-makers speeches, official media of the Chinese government, articles of the academic journal, documents from leading policy publications, and the studies of think tanks. This research paper comprises of five sections; the introduction is the first part, the second section investigates into the background and theoretical thoughts, third section review identifies CPEC involving the potential to foster the processes of regional integration. Chapter four presents a comprehensive discussion of the effects of CPEC on Pakistan's relations with China, Iran, Afghanistan, India, and CARs as a geo-economic strategy. Section five supplies summary remark, CPEC interlinked goals of regional connectivity and development, and finally, it suggests a future research agenda.

2. THEORETICAL UNDERPINNING

The concept of globalization is critical, as it has interconnected the entire world through the development of international markets, which has enhanced cooperation and economic activities worldwide. Baldwin and Wyplosz (2006) argue that the global markets are interlinked, and changes in one market affect the economies of other markets, which directly or indirectly offered links with each other by interplaying the concept of economic integration. Hence, economic integration narrates a commercial arrangement between the economies (two or more than two); however, it is a regional integration sometimes for reducing the trade and economic barriers and increasing the bilateral economic relations and trade (Baldwin, et al. 2006).

Liberal theorists typically believe in economic cooperation, trade interdependence, establishes peace, and it minimizes risks involving armed conflicts. The liberal theories are well-recognized approaches, and it presumes that economic relationships and international trade enhance stakes

among the integrated nations, which are joint economically, and it helps in reducing countries' erupting conflicts. The theory Neo-Functionalism significantly explains regional integration. Jensen (2013) contends that the theory of Neo-Functionalism offered in 1950, reports on the concept of the European integration, and it explains supranational bodies contribution such as European Commission networks development presents such combination. This theory recognizes the idea of "spillover" as it debates that the nation's cooperation in one direction produces inducements to open regional collaboration in the other sectors. This theory also argues that the higher tendency in the interaction of regional states and units economically integrated, the international body formed for managing the possibilities of integration to enhance the social integration process further. However, scholars have criticized this theory as it assumes a degree of automaticity within integration processes, and it has not provided the information to discuss the growing limitations and protectionism for regional integration, which member states might raise (Jensen, 2013).

The projects of CPEC would integrate South and Central Asia, Middle East, Iran, Western China, and Afghanistan. However, it needs a political determination, and the peaceful situation is critical in developing interdependence among the regional states. Khan and Marwat (2016) assert that the successful efforts to transform the resources into comprehensive and sustainable local development in the region depend on coordination and mutual efforts through linkages of a broader range of various regional and intra-regional stakeholders. The CPEC projects offer the connectivity of markets for areas seeking full resource options for territorial integrity and development. The efforts of regional states based on coordination and connectivity are useful in linking the concept of demand and supply, and markets offer reduced cost of doing viable business across territorial countries borders. Which increase the cross-border economic, trade, and investments. Regional integration provides a platform to states for regional economic cooperation and other moves, which are beneficial to come closer with other regional nations by concentrating inter-dependence to cultivate stakes in each state's stability. Therefore, regional countries emphasize to avoid conflicts, and these states focus on finding out the diplomatic and other ways to resolve the disputes peacefully (Khan, et al. 2016).

The "Neo-Functionalism Theory" remains applicable and supportive of the potential of CPEC projects to expand regional integration. The states in South Asia are blemished with bilateral disputes, internal disparities, local challenges, and threats, which are the barriers to enhance trade volume. These states insufficiently have shallow trade levels, and regional nations need to resolve these conflicts through a strong political will. The regional economic interdependence is helpful and offers many states a greater inclination to resolve the disputes through negotiations, dialogs, and other peaceful diplomatic ways. In the same manner, the maturity of economic integration offers a secure political integration, stability, and peace. The projects of CPEC will establish regional integration by strengthening trade, and integration, by stimulating regional economic growth, interaction, and coordination across the region. This type of regional state integration empowers the coherence of constituent nations in enhancing regional attractions for maintaining sustainable economic growth, and it helps to integrate development into the global economy. Regional integration has to accompany by region-based progress by improving competitive logistics, infrastructure connectivity, production-value chain integration. Regional states adequate support to international trade and convergence in regulatory policies and other trade-related policies.

3. CPEC FOSTERING REGIONAL INTEGRATION

Scholars debated and believed that CPEC would help in defusing tensions and regional conflicts by promoting regional integration, harmony, and economic cooperation among adjacent nations. According to the report of World Bank (2016), identified that poor transportation conditions, infrastructure, connectivity, and inadequate facilities for trade and commerce are the barriers and reasons for weak regional integration in the CARs and South Asian countries. The connectivity within the regions is critical for integrating, and CPEC projects would be playing a contributory role in regional development. CPEC could play a significant role by bridging the regional states for regional integration to materialize gravitational pull of geographical proximity for goods and services exchange and movement. CPEC is a platform for regional markets connectivity and interaction between resourceful enrich and poor resource regions. Pakistan and China are surrounded by massive demand and supply at local and international markets, and CPEC could be the best and useful supply chain for formerly poorly connected countries such as Iran, Afghanistan, Middle East, South, and Central Asian states. CPEC projects would ensure open trade, economic cooperation, well-organized resource allocation, and regional markets integration. Accordingly, CPEC would play a critical role in expediting the rise of South Asian states and the rest of the world, and CPEC projects might prove Asian countries eventually backbone for regional development and economic integration (Bank, 2016). The greater regional cooperation and integration will bring more enormous benefits and a win-win environment for all the regional nations. Certainly, CPEC will have a positive impact on regional integration if the other countries join it. However, if the other neighboring countries are trying to create hurdles for CPEC, then perhaps it will hurt regional integration. However, economic effects of CPEC on regional integration would positively, because commercial has own dynamics to attract, mostly the private sector which becoming more and stronger in many countries and they go for profit if they see any profitable prospects or opportunities so they indeed go for it and that can perhaps enhance the regional integration (Fazal-ur-Rehman, 2018).

Ahmed (2017) claims that Pakistan and China have officially invited Russia to join the mega project of CPEC, and both countries have offered Russia to start trade through Gawadar seaport in Pakistan. The main aim is to boost trade and economic cooperation via Sino-Russian cooperation by participating in BRI (Belt and Road Initiative). The BRI emphasizes to increase openness in global trade and regional economic integration as this project intends to cover the trade openness and development for Central Asian countries (Ahmed, 2017). CPEC is an open-ended venture. It's not an insular venture; its open to all now in that context its full potentials will be utilized. Gwadar Port gives access to the Middle East, East Africa, and Europe, so we think that for making full use, the full potential of CPEC. It has to be region-wide gradually for that Iran, Afghanistan, and CARs, and whenever India decides now, all should become part of it. For them also it's a win-win situation. CARs so for their only outlet has been through Russia, which is long and more expensive. Iran could exports to China from both ways. That is why it is in the interest of Afghanistan; it is the interest of CARs, it is the interest of Iran. It means to be a greater integration (Masood, 2018).

CPEC would improve regional development, cooperation, and integration that will facilitate regional and global trade through improved infrastructure and transport connectivity. It will ease trading with better facilities in the region by creating more trade opportunities as this region strategically is located at the crossroads of Asian states between oil-rich states in the West and other dynamic economies of Central Asia and Southeast Asia. Kher (2014) content that, in South Asia, the

requirement of resources to develop infrastructure is gigantic. Regional cooperation for development is likely to create broader global markets, and it will offer multidimensional agencies to attract private sector investments to build the physical infrastructure in South Asian states (Kher, 2012). It is the era of globalization, which has integrated the world by linking global economies as the trends of global trade. The economic-corridors have developed transportation facilities, and these routes have made possible the process of integration. CPEC is likely to strengthen the strategic alliance between countries of China and Pakistan, as it seems probable in minimizing the conflicts between India and Pakistan. A peaceful situation in Pakistan will have a positive impact in South Asia, particularly in Afghanistan.

4. THE EFFECTS OF CPEC ON PAK-CHINA RELATIONS

In historical records, the Pak-China relationship remained military-oriented significantly; however, CPEC has developed a new relationship between Pakistan and China to make their ties widely economic-oriented. Which emphasizes on regional trade, investment opportunities, and energy projects cooperation (Kumar, 2007). Small (2015) contends that the potential mega project of CPEC will further deepen the economic, political, and people to people relationship between China and Pakistan (Small, 2015). Economically and strategically, CPEC is vital for Pakistan and China, as it will provide China access to Middle Eastern states, Iran, Afghanistan, and Africa through the Gawadar port of Pakistan. Kumar (2007) argues that the Gawadar seaport of Pakistan will be under Chinese control, and this port is just 400 kilometers away from Hormuz Strait. It is strategically essential for the transportation of Chinese oil and energy needs from West Asia as it will reduce the distance of Chinese maritime transportation from 12,000 to 3000 kilometers. It is presumably inevitable for China to access the Indian Ocean through Pakistani Gawadar seaport as it provides a secure route and less vulnerable to its present Malacca Dilemma. This route offers China economic security to gain access to West Asian countries for the time being when Strait of Malacca increasingly becomes a contested territory between China and other global industrial players (Kumar, 2007).

At present, China transports almost 80% of its energy and oil requirements by using Strait of Malacca as China exclusively feels severe threats in the region against its interests of energy and economic security. Saunders (2014) asserts that China is continuously facing this situation because of increasing conflicts between regional and world players with China in the East and the South China Sea. It is the reason why China looks for viable alternative transit routes that can safeguard its economic and security concerns, and CPEC is a suitable option for China to access the Indian Ocean through Pakistan's Gawadar seaport. The US rebalance policy for the South Asia region, Asia-Pacific gained a unique strategic position for the Obama administration as they signed the Trans-Pacific Treaty between the US and its allies testified it. In the Asia-Pacific region, the rebalance policy of the United States involves economic, strategic, and military focus for South Asian states, including India, to shape the balance of power in the region by covering the Indian Ocean and Southeast Asia (Saunders, 2014). CPEC shows the long-lasting friendship between both states. The Sino-Pak need to realize the obligations of both sides, limitation and compulsions to mitigate the challenges and threats on the way that forces inimical to this mega project. The CPEC presents the strength and importance of long-lasting friendship between Sino-Pakistan.

5. THE EFFECTS OF CPEC ON PAK-INDIA RELATIONS

The response from India on CPEC is negative as observers either ignored the CPEC project or rejected it by declaring it impracticable. CPEC is passing via Gilgit-Baltistan, and India claims it disputed territory while it is a part of Pakistan administratively. Ranjan (2015) reports that there are territorial disputes involving Pakistan, India, and China, and these conflicts did not resolve yet. However, regional dynamics in South Asia persistently include a remarkable increase in bilateral trade between China and India, regional and global growing bilateral cooperation on different fronts, including the BCIM-EC development, and efforts to revive the peacebuilding process between Pakistan and India. The CPEC offers India promising and exciting choices that CPEC innovatively might open new outlooks based on regional political stability, cooperation, and economic growth in the region of South Asia (Ranjan, 2015). Khalid and Anam (2015) report that India will also extract trade benefits to inaugural trade routes through Pakistan by joining CPEC. It is always an ambition of India to avail access routes to CARs and Afghanistan for broader connectivity of its products in the regional and global markets. However, the conflicts between the two South Asian key players, Pakistan and India are the key hurdles, and both countries need to start dialogues to resolve their political and economic and security issues by easing their strategies and policies. India and Pakistan need to negotiate and resolve outstanding conflicts via diplomatic dialogs for collective benefits for the two billion-plus population of South Asia. The venture of CPEC has a higher capacity for materializing quicker culmination of the India-Pak-Iran gas pipeline project, which can provide India and Pakistan the required energy (Khalid, and Anam, 2015). Wagner (2016) contends that CPEC can also develop a conceivable favorable scenario in which this venture might exercise moderating effect on the relations of Pakistan and India, and both countries can resolve Kashmir dispute diplomatically through dialogues. This venture might also impact Gilgit-Baltistan constitutional status, and it will lead to mutual trust among Pakistan, China, and India relations, political stability, regional cooperation, and development (Wagner, 2016).

Pakistan and India need to prioritize regional cooperation, and both states have to sit sideways their disputes and resolve their mutual conflicts stepwise and select the path of geo-economics. At present, the difference between Pakistan and India is preventing India from becoming a CPEC member state. However, the participation of India will trigger the applicability of CPEC for economic growth and regional integration, and it will be mutually beneficial for both countries as well. It will also develop cooperation by building trust, which would stimulate in resolving disputes between Pakistan, and India harmoniously.

6. THE EFFECTS OF CPEC ON PAK-IRAN RELATIONS

Pakistan and Iran have historical and cordial diplomatic relations for decades, and both countries share long borders of 800 kilometers. There is no land or political dispute, unlike with India and Afghanistan. Pakistan becomes the first state to recognize the post-Revolution government of Iran, and both countries maintained a positive relationship as Iran was also a first state to acknowledge Pakistan (Vatanka, 2015). Ali (2015) contends that the linkages of Irani port of Chabahar with the Pakistani port of Gawadar, CPEC, and Bangladesh China India Myanmar (BCIM) will influence positively. The connectivity of these megaprojects will foster a new beginning of trade and economics in the East, West, South, and Central Asian countries. Iran has already indicated to participate in the regional development and willing to cooperation between Pakistan's port of

Gawadar and Chabahar Port of Iran. The connectivity between these two ports will allay the general ambivalence feelings between Pakistan, Iran, and India concerning the Gawadar seaport of Pakistan run by China and port of chabahar of Iran supported by India (Ali, 2015). The president of Iran, Hassan Rohani, met with Pakistani Prime Minister Muhammad Nawaz Shareef on September 21, 2016, during the General Assembly session of the United Nations (UNGA), and Irani president announced the desire of Iran to participate in CPEC (Mirza, 2016).

Iran decided to opt the option of participation in this venture in September 2015, both countries decided to make better linkages between both seaports and connectivity by roads, and railways tracks were agreed to enhance the scope of cooperation, trade-economic, and transportation. Pakistan will connect Gawadar to the border of Iran, situated around 80 kilometers away, which is an easy task to faster the linkages of two sister ports for enhancing economic and trade in the region. The Iran-Pakistan pipeline can make Pakistan a transit country for Iran's mega project of a gas pipeline, which will lead to China as well. This route is viable and shortest for connecting Iranian more magnificent gas fields with China to fulfill its energy needs. Therefore, the trilateral relations between China, Pakistan, and Iran are improving, which is a positive development for regional integration, as it will bring massive benefits in regional trade and economic growth.

7. THE EFFECTS OF CPEC ON PAK-AFGHAN RELATIONS

The project of CPEC will also be a positive venture for Afghanistan as it might improve the relations between Pakistan and Afghanistan, which will lead to developing greater social, cultural, and economic integration, and both countries will have an environment of the interdependence of cooperation. Khan (2016) argues that cooperation and integration between both countries will increase interference, which will lead to making connectivity to Central Asian countries, and the region can develop faster economic and trade links (Khan, 2016). Khalid and Anam (2015) report that Afghanistan is a landlocked state without access to the sea and the CPEC project might establish a vital geostrategic standing. If CPEC extends towards Afghanistan, this country might become a principal beneficiary of this venture, as CPEC will open a corridor for economic development for the fragile state of Afghanistan to enhance economic growth in the region that might assist Afghanistan's weak economy back to normality. Pakistan will construct a motorway of 265 kilometers from Peshawar to the city of Kabul to connect Afghanistan to this mega venture. The connectivity with CPEC may integrate Afghanistan with regional states and regions by allowing this state to initiate commercial operations by using the Indian Ocean. The CPEC will tremendously help Afghanistan in reducing traveling time and distance. Thus, CPEC will offer Afghanistan an ideal situation to take advantage of the growing opportunities of economic growth from the openings of these corridors (Khalid, and Anam, 2015).

Roy (2017) asserts that the development of new infrastructure in Pakistan through CPEC will provide Afghanistan new trade and investment openings. It will provide access to consumer markets of South Asian countries by reducing import costs and increasing exports in the regional and global markets. Afghanistan will be in a position to increase its trade and economics with other regional states, which will be helpful to stabilize its economy (Roy, 2017). Afghanistan and Pakistan governments should join their hands for collaboration. Both states need to stop blame games by taking meaningful and serious actions/dialogues for resolving the existing disputes to control cross-borders

terrorism attacks, militancy challenges, and socio-economic adversities, which both countries encounter. Thus, the effects of this mega venture will fetch definite advantages for Afghanistan and Pakistan and will improve the relations between both states, which provide sustainable development, peace, integration and political stability in the region.

8. THE EFFECTS OF CPEC ON PAK-CARS (CENTRAL ASIA REPUBLICS) RELATIONS

The relations between Pakistan and Central Asian Republics will reach the new heights in building positive cooperation through CPEC as this mega venture would enhance economic growth and mutual trade benefits for both sides. Amir (2017) contends that Central Asian states, Uzbekistan, Turkmenistan, Kazakhstan, and Kyrgyzstan, export their energy resources through the borders of Russia. These CARs countries are land-locked and have no access to seaports. However, CPEC will provide them opportunities to access the Indian Ocean, regional, and global markets for export and import activities (Amir, 2017). The Central Asian Republics are enriched with oil resources and natural gas, particularly, Turkmenistan, Uzbekistan, and Kazakhstan have primary energy resources and regional and other global states such as China and Pakistan want to build good relationships. These five CARs states are land-locked, and they are also willing to have access to seaports by developing energy channels diversification; however, CPEC is a mega plan, which is a suitable channel for CARs to boost up economic and trade activities. The Central Asian states would be export their world's largest natural resource of energy by using the gas pipeline and transit trade routes through Pakistan with CPEC development. The CARs can ship their products smoothly to regional countries, Middle Eastern nations, and European countries via the seaport of Gawadar, Pakistan.

Hussain (2017) argues that CPEC is a substitute energy route for CARs such as Kazakhstan, Turkmenistan, Azerbaijan, and Uzbekistan. At present, these land-locked states are exporting their oil and energy resources by using the pipe network through the Black Sea and have a dependence on Russia. Russia imposes high charges as compared with global market rates on these land-locked countries for transporting goods as these states have no alternative. CPEC is a suitable and economical alternative trade route for Central Asian Republics nations (Hussain, 2017). In a situation of blocked Persian Gulf, the seaport of Gawadar Pakistan will provide the alternative trade route, which declared as the all-times access point. Sajid (2017) contends that This trade route is suitable, faster, and cheaper than the South Asian path leading to Mediterranean, Suez, and Atlantic and to Baltic and Atlantic to reach the port of North Sea. Russia will reduce delivery time of almost 20 days through the CPEC route, and it can minimize 400 to 500 US dollars cost of each container as compared with the old trade track (Sajid Hussain, 2017). In this scenario, the land-locked countries of CARs might immensely gain benefits to access global markets through this trade route of CPEC for exporting their gas and energy resources.

9. CONCLUSION

Economic corridors play an essential role in integrating economic growth for economies across the region and world. Therefore, CPEC will provide the foundation for regional development, integration, and efficient management of infrastructure expansion. For regional and global integration, well-organized networks of transportation are essential to increase economic activities. Thus, newly developed infrastructure through the CPEC project would encourage and faster production networks for oil, energy, and other goods across East, West, and Central Asia, as well as

Middle Eastern states, by increasing regional and global trade activities. It would accelerate regional as well as global economic integration. The mega venture of CPEC will provide a robust platform for regional integration if other regional countries such as Iran, Afghanistan, CARs, and might be India also actively join this project. Pakistan and China are desirous that India and other regional states join CPEC for regional development, integration, political stability, and a comprehensive peaceful setting in the region. However, all regional states have shown their interests to become a member of CPEC except India. China-Pakistan wants to see CPEC as a beneficial project for regional integration, stability, development, and cooperation, and Chinese officials are trying to play their diplomatic role to bring Pakistan and India closer in resolving the disputes peacefully. If Pakistan and India build a trustable environment, resolve their political differences, and initiate economic growth and trade ventures, it will develop a viable situation in the region for regional integration and development. The mega-investment via CPEC offers numerous advantages such as people to people interaction, greater economic and trade integration, sustainable peace, political stability, and regional development. CPEC has strengthened regional and strategic alliances between the Sino-Pak, and it would help in resolving and minimizing the political disputes between India and Pakistan. The mega venture of CPEC will have numerous consequences on regional geopolitics, and geo-economic activities, and scholars have recommended further research. In this framework, relations normalization between Pakistan and India and constructive relations between Afghanistan and Pakistan are critical and indispensable preconditions. Besides, it is need of the time for developing regional states fundamental reassessment, and an approach based on predominantly-security for all member states to build trustable cooperation for regional integration and economic development.

4. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

5. REFERENCES

- Ahmed, A. (2017). Pak-Russia Relations and Future Prospects. *Defence Journal*, 20(7), 14.
- Ali, A. (2015). China Pakistan Economic Corridor (CPEC): Prospects and challenges for regional integration. *International Journal of Social Sciences and Humanity Studies*, 7(1), , 1-15.
- Amir, F. (2017). CPEC and Regional Integration. *Pakistan Development Review*, 56(4), 579-597.
- Baldwin. (et al. 2006). *The economics of European integration*, McGraw-Hill London.
- Bank, W. (2016). *Regional Integration and Spillover: South Asia* (The World Bank, 2016), accessed April 21, 2016, <https://www.worldbank.org/content/dam/Worldbank/GEP/GEP2016a/Global-Economic-Prospects-January-2016-Spillovers-ECA.pdf> GLOBAL ECONOMIC PROSPECTS.
- Fazal-ur-Rehman. (2018). Interview: Dr Fazal ur Rehman, CPEC and Regional Integration, Director Policy Research Institute of Islamabad. In I. Hussain (Ed.).
- Hussain, E. (2017). China–Pakistan economic corridor: will it sustain itself?.. *Fudan Journal of the Humanities and Social Sciences*, 10(2), 145-159.
- Jensen, C. S. (2013). “Neo-functionalism: Logic and Critique,” accessed 27th August, 2016, available at <http://hum.port.ac.uk/europeanstudieshub/wp-content/uploads/2013/05/Module-4-extract-5> Neofunctionalismlogic-and-crtique.pdf.
- Khalid. (and Anam, 2015). Impact of CPEC on Regional and Extra-Regional Actors. *The Journal of Political Science*, 33, 23.

- Khan. et al. (2016a). CPEC: Role in Regional Integration and Peace. *South Asian Studies*. 31(2), 103.
- Khan, M. (2016b). Domestic and External Dimensions of the China Pakistan Economic Corridor China-Pakistan Economic Corridor: A Game Changer: Institute of Strategic Studies.
- Kher, P. (2012). Political economy of regional integration in South Asia. UNCTAD Background Paper No. RVC5, Geneva: UNCTAD.
- Kumar, S. (2007). The China-Pakistan Strategic Relationship: Trade, Investment, Energy and Infrastructure. *Strategic Analysis*, 31(5), 757-790.
- Masood, K. (2018). Interview: Ambassador Kalid Masood, CPEC and Regional Integration, Chairman Institute of Strategic Studies Islamabad. In I. Hussain (Ed.).
- Mirza, Z. L. (2016). Chinese Vision Of One Belt One Road And Strategic Dimensions Of China Pakistan Economic Corridor. *Margalla Papers*. 2016.
- Ranjan, A. (2015). The China-Pakistan economic corridor: India's options. New Delhi.
- Roy, M. S. (2017). Afghanistan and the Belt and Road Initiative: Hope, Scope, and Challenges. *Asia Policy*, 24,(1), 103-109.
- Safitri, H. (2016). Economic corridor policy, land concentration and 'social exclusion'java's economic corridor policy implementation.
- Sajid Hussain, S., & Khan, M. A. (2017). CPEC; A Roadmap of Region's Development. *FWU Journal of Social Sciences*, 11(2).
- Saunders, P. C. (2014). China's rising power and the US rebalance to Asia: Implications for US-China relations China's Power and Asian Security (pp. 85-107): Routledge.
- Shoukat et al. (2017). Does Infrastructure Development Promote Regional Economic Integration? CPEC's Implications for Pakistan. *Pak. Dev. Rev*, 56, 455-468.
- Small, A. (2015). The China Pakistan axis: Asia's new geopolitics: Random House India.
- Vatanka, A. (2015). Iran and Pakistan: Security, diplomacy and American influence: Bloomsbury Publishing.
- Wagner, C. (2016). The Effects of the China-Pakistan Economic Corridor on India-Pakistan Relations.
- Wolf, S. (2016). The China-Pakistan Economic Corridor: An assessment of its feasibility and impact on regional cooperation. Paper presented at the SADF Comment, South Asia Democratic Forum (SADF), Brussels, Belgium.



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USES OF NEW/SMART MATERIALS IN THE GREEN BUILDING WITH SUSTAINABILITY CONCERNS

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ABSTRACT

Due to the importance of energy in green buildings, one of the most critical solutions to achieve a sustainable environmental architecture that tries to cope with nature instead of overcoming it and use of renewable energy instead of fossil fuels. Smart architecture and building systems can reduce energy consumption as well as provide desirable comfort to residents of the green building. The widespread and growing need of the community to buildings and housing, the necessity of using new construction systems and modern materials to increase the pace of construction, light-weighting, increasing service life and also buildings' retrofit against earthquakes have been proposed more than ever. Solving problems such as long run time, poor service life, high cost of building construction, environmental issues, and existing pollution in today's cities requires a public determination and fundamental changes in the type and use of materials, building systems, and architecture. The need to achieve such an ideal is to apply technology again to produce smart and new materials that guide the ecological behavior of the building towards smart energy management; this means the application of materials that best adapt to environmental changes. The use of smart materials reduces energy consumption in green buildings with a sustainable development approach that was reviewed and investigated using a descriptive-analytical method.

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1. INTRODUCTION

Building and living have changed dramatically over the past two decades. In fact, it can be stated that in our times, the increasing population and urban life, along with the excessive energy consumption and pollution caused by human activities, is a great problem in environmental protection, so the green architecture is one of the important architectural currents. Green and sustainable titles are indeed the attributes that characterize the existence of adaptation to the environment and persistence in a built subject, such as a building. Each community should be

supported by the present and future residents. In this regard, the building designing and construction should be done in such a way that it is compatible with a sustainable and smart environment and with the use of state-of-the-art technologies. A sustainable and green building is set along with nature to further exploit the environmental facilities and provide human comfort. A sustainable and green building is regulated and controlled using sophisticated and integrated systems. The architectural design, in addition to the beauty and function of the spaces, tries to use the natural factors and resources such as renewable energy (e.g., solar energy, geothermal energy, and the wind) and plants to regulate environmental conditions and for the welfare of beneficiaries. Green architecture arising from sustainable architecture and development is the result of human need today against the consequences of the industrial and consumption of the present era. Protecting the world's natural resources, immunity from air pollution and other environmental pollutions, protection of the ozone layer, physical and mental health, the future of humanity has been one of the issues discussed in this regard, and its necessity has become more and more evident as a global task. (Modaresi, 2019)

This study amplifies the use of smart materials, aiming at the reduction in energy consumption. This study highlights the harnessing of the mentioned structural and building components through which there will a drastic decline in energy loss. In the first step the study tries to define sustainability, then it puts effort on to describe the sustainable design and related principals.

2. SUSTAINABILITY IN ARCHITECTURAL DESIGN

Sustainability is meant to meet the needs of today's generation without sacrificing the ability of future generations to meet their needs (Mohammad, 2013).

In this definition, two critical concepts of prospecting and maintaining resources have been considered. The next generation has a right upon today's generation and requires duty for today's generation to endow the earth in full health to the next generation. To preserve resources, it is necessary for today's generation to protect all renewable and non-renewable resources (Keikha, 2018). Sustainable development is a kind of development that improves human health and ecological systems in the long run. This definition emphasizes the continuous process of moving toward healthier natural and human communities (Kasmaee, 2012).

2.1 SUSTAINABLE DESIGN

The proposed definitions for sustainable design are sometimes more focused on the idea of environmental sustainability concerning architecture, including a sustainable building is a kind of building that has the least adverse effects on the natural environment over the life of the building as well as regional and global deployment. The principle of sustainable design is based on the fact that the building acts as a minor part of the peripheral nature and a part of the ecosystem and is set in the life cycle. The concept of sustainability in architecture can be translated into the vision and design of future construction, not only with the physical sustainability of the building but by the sustainability and preservation of the planet and its energy resources (Keikha, 2018).

Thus, it seems that sustainability is based on a pattern where available materials and resources are deployed more efficiently before being wasted or ignored. In other words, sustainable design is focused on building capability to integrate environmental and atmospheric factors and transform them into spatial qualities, comfort, and form. According to the principles of humanization, sustainable architecture is of particular importance regarding the quality of the interior spaces of the building. Undoubtedly, the desired quality is not suitable regardless of nature, suitable lighting of spaces, and

air conditioning. Besides, since the sustainability and persistence of the building per se are considered as a phenomenon, high-quality construction, using long-lasting materials must also be considered. It is possible to achieve such conditions using systematic design, efficient management, and the application of the latest technologies concerning building materials (Kiomarsi and Ahmadipour, 2001).

2.2 SUSTAINABLE DESIGN PRINCIPLES

Location recognition: Sustainable design is posed by a cognitive site because if we are sensitive to the delicate spatial issues, we can settle without degradation. Knowing the location, such as the direction of light, helps the design and protects the environment and even facilitates access. **Relationship with nature:** In designing the site, whether within the city or in the natural environment, it has a coordinated design with nature to return to environmental life, and the effects of design help us have a natural space. **Knowledge of natural processes:** There is no waste in nature, production of an organism provides food for the other, and in other words, natural systems have a closed loop. By working with living processes, we respect the needs of the species, and by a design that can put itself in the cycle of nature, we return the design to life. **Understanding environmental impacts:** Sustainable design is an attempt to identify the environmental effects on the site evaluation. Negative environmental impacts can be mitigated by impressive energy efficiency, structures' technology, and sustainable materials' selection. **Understanding people:** Sustainable design should pay attention to a wide range of cultures, generations, religions, and the habits of people who use or inhabit it, which needs to be responsive to the needs of the people and the community (Husseini, 2011).

2.3 THE PRINCIPLES OF GREEN ARCHITECTURE

2.3.1 CONSERVATION OF ENERGY

Each building must be designed and constructed to minimize the need for fossil fuels. The necessity of adopting this principle in the past can undoubtedly be denied according to the types of construction. Perhaps due to the great variety of materials and technologies in contemporary times, such a principle in buildings has been forgotten. Now, using different materials with different combinations of them, they change the buildings of the environment according to the needs of the users (Hamideh, 2018).

2.3.2 WORKING WITH THE CLIMATE

Buildings should be designed to be able to use the climate and local energy resources.

The shape and the deployment of the building, as well as the placement of the interior spaces, can be in such a way that it causes the height of the comfort level inside the building and at the same time can reduce the fossil fuel consumption by proper insulation of the structure. Both processes are overlapped and have many common points.

2.3.3 REDUCING THE USE OF NEW RESOURCES

Each building should be designed to minimize the use of new resources and to create a source for building other structures at the end of its service life.

Although the orientation of this principle is similar to the other principles referred to the new buildings, it must be noted that most of the resources available in the world are employed in the current built environment, and it is necessary to repair and upgrade the existing structures to reduce

environmental impacts, which is of equal importance to the creation of new structures. It should also be noted that there are not enough resources to create built environments in the world that can be used to reconstruct every generation of buildings. A green process may consider the judgment of this subject on available resources only. These changes should be welcomed if the resources required to change a building be less than the resources required to destroy and restore it. However, this does not lead to a lack of respect and commemoration of the historical significance of the structure. Moreover, these structures may also have other values that are required to pay attention to them. (Lahiji, 2018)

2.3.4 HAVING RESPECT FOR USERS

Green architecture respects all the people who use the building. This principle appears to have little relation to pollution caused by global climate change and the destruction of the ozone layer. However, the green process in the architecture that includes respect for all common resources in a complete building does not exclude humans from this collection. All buildings are made by humans, but in some structures, the fact of human presence is respected, while in others, an attempt is made to reject the human dimension at the construction site. (Lahiji, 2018)

2.3.5 HAVING RESPECT FOR THE SITE

Each building has to touch the ground in a calm and light way.

"The building should touch the ground in a quiet and light way," said Australian architect Glenn Murcutt, a feature of the interaction between the building and the site, which is essential for the green process, and of course it has broader characteristics. The building that consumes energy greedily, generates pollution and is alienated from its consumers and users; thus never it touches the ground in a gentle and light way (Torabi and Roshan, 2015).

2.3.6 HOLISM

All green principles require participation in a holistic process to create the built environment.

It is not easy to find buildings that have all the basics of green architecture since green architecture is not yet fully understood. A green architecture must include more than one individual building block and must include a sustainable form of the urban environment. The city is a creature beyond the building complex; in fact, it can be viewed as a collection of interacting systems - systems for living and recreation that are molded in the shape of structured forms. With a closer look at these systems, we can map the face of the future city (Torabi and Roshan, 2015).

2.4 THE BENEFITS OF A GREEN BUILDING

- ✓ It satisfies the needs of its inhabitants.
- ✓ It provides health to its residents with satisfaction, productivity, and gayety.
- ✓ It requires the measured use of sustainable architectural solutions, construction with non-toxic materials, effective use of materials obtained from sustainable natural materials, relying on the sun on daylight, thermal and electrical energy, and recycling materials.
- ✓ An architectural synthesis of these solutions in a building, which is an honor to its users and is in the service of the natural world (Najafi, 2002).

Some aspects of green architecture are:

- ✓ Increased comfort, ability to live and productivity
- ✓ Improved durability, quality, and maintenance
- ✓ The sustainability of the internal environment

- ✓ Money savings by reducing the cost of life
- ✓ Understanding the options of high-performance solar buildings
- ✓ Choosing the field of green building materials to play your role to help protect the environment

2.5 GREEN MATERIALS

Avoid using those chemicals that destroy the ozone layer in mechanical and insulation equipment.

Use the building materials obtained from the site. Transportation is important both in energy consumption and in public pollution.

Use waste materials that can be recoverable in the cycles of nature, such as cellulose insulation, homasote, plywood, the tiled floor made from ground glass, and recycled plastic in the form of timber and flooring.

Search the authentic wood products. Use exclusively guaranteed timber which was obtained from controlled forests.

Avoid using substances that are polluting with gas: They release the base solvent of color and oil, glues, carpet, scrap wood, and many other building materials and products, formaldehyde, and volatile organic VOC compounds (Zhou, 2012).

The main features of the smart architecture are:

- Adaptable
- Dynamic and Mobile
- Flexible and consistent with the environment
- Reactive and responsive (Turkgizi and Farokhzad, 2013).

In this paper, it was tried to name some materials that are compatible with green and sustainable architecture that only two of them have been analyzed.

3. SMART MATERIALS

Smart materials are materials and products that can understand and process environmental events and react favorably to it. In other words, these materials are capable of change and can change shape, form, color, and internal energy in a reversible manner in response to the physical or chemical effects of the surrounding environment. If we classify the materials into three non-smart, semi-smart, and smart materials, the first group, i.e., non-smart materials, do not have the above particular characteristic, the semi-smart materials can only change their shape and form for once or for a while in response to their peripheral effects; however, in smart materials, these changes are repeatable and reversible. Smart materials are also known as "flexible" and "adaptive" materials, and this is due to their particular feature in adjusting themselves to environmental conditions. The effective chemical and physical variables introduced below are the stimuli that smart materials react to.

1. UV-ray light: The ultraviolet and visible part of electromagnetic rays
2. Temperature: The temperature changes that make a physical system like a human body.
3. Pressure: Pressure difference created in a region
4. Electric field: The field created around an electric charge.
5. Magnetic field: The field created around a magnet or a mobile electric charge

Chemical environment: The presence of a particular element or chemical compound such as water (Kiomarsi and Ahmadipour, 2001).

3.1 TYPES OF SMART MATERIALS

The existing building materials including traditional, natural, and artificial, are classified according to their characteristics such as appearance, texture, chemical composition, physical properties, environmental effect, and so on. However, smart materials are classified based on other properties related specifically to differentiating between smart materials and traditional materials. In fact, the proposed classification of smart materials is based on the following three properties:

1. The capability of changing internal properties:
 - Anamorphic smart materials
 - Halochromic smart materials
 - Delinking smart materials
2. Energy exchange capability:
 - Smart materials emitting light
 - Smart materials producing electricity
 - Energy-saving smart materials
3. The ability to change and exchange internal materials:
 - conductive smart materials

3.3 POWER CONSUMPTION REDUCTION WITH SUITABLE UTILIZATION OF SMART MATERIALS

3.3.1 THERMAL EXPANSION SMART MATERIALS

This type of material has some inherent property that enables them to react in response to changes in ambient temperature around the environment. Temperature variations may have an inactive effect so that the material continuously adjusts the state of its internal temperature with its natural state through the outer shell and if they have an active effect, a kind of active heating is created using an electric field through contact.

An example of thermal expansion materials (TEM) is expandable materials that have an expansion coefficient. However, their most important application in architecture is for heating thermostats for building services as well as specific drivers in greenhouses and in building facades to control and manage energy. The other applications of them are in the ventilation system of the building rooms. The system works in such a way that the system is open or closed in certain temperatures to provide suitable space ventilation conditions. They can also be designed as components of the ventilation system in the building facade by lifting or dropping parts of the roof cover automatically. The application of this type of smart materials in building decreases the amount of energy consumption to a considerable extent by producing proper ventilation of the need for complex systems and excessive spending (Saanei and Masudi, 2008).

3.4 HALOCHROMIC SMART MATERIALS (SMART MATERIALS WHICH CHANGE COLOR)

These materials can change their color or visual characteristics in response to one or more external stimuli. Due to their stimulus, these materials include various types. Some of them, which have been considered in many architectural applications include photochromic, thermochromic, and electrochromic materials (Michelle, Britain, 2005).

Currently, much attention has been paid for photochromic materials (PC) by the architects. Although the application of these materials was primarily due to their beauty aspect (because of the

color spectrum they created in front of the light) (Figure 1), researchers did many research on these materials so that they can use this product for other functions such as reducing energy consumption or temperature changes of these materials. The electrochromic materials are also used in the architecture of the electro-optic glasses. These materials can change their visual characteristics, i.e., their transparency by exposure to solar radiation (Axel, 2007).



Figure 1. Windows made from photochromic glass

3.5 ENERGY-SAVING SMART MATERIALS

Transparency and heat capacities can be used simultaneously. Whenever the temperature of the interior of the building is higher than the outside, a bidirectional flow is established. The radiation energy is transmitted into space, whereas the internal thermal energy is driven outward. Changes in the amount of glasses' adsorption finally affect their net conductivity and change the balance mode of these currents. Many materials, such as photochromic, thermochromic, thermotropic, electrochromic material, liquid crystals, and suspended particles' system can be used in building smart windows. In many cases, the smart materials used in windows can be used interchangeably, for example, the electrochromic materials, the liquid crystal, and the materials with suspended particles are all used in controlling the conduction of light and heat, the highest difference in these materials is caused by the electric current (Kienzl, 2002).

These materials and products are capable of storing energy in themselves, whether explicitly or implicitly, such as the form of light, heat, hydrogen, or electricity, which also have the reversibility capability. Thus, these materials are capable of storing energy in different ways. However, among these smart materials, heat storage has gained more attention. These materials have a kind of inherent characteristic, which enables them to store energy as heat or cold (vs. heat) as latent energy (Michelle, Britain, 2005).

3.6 THE MATERIAL APPROACH IN ARCHITECTURE

The selection of materials to use in architecture has always been based on many different criteria. Function and expense play an implicit role; however, the final selection is often based on facial appearance, beauty, ease of construction due to the skill of the human force, local or regional access, as well as materials used in the facades of nearby buildings. A lot of advanced materials were created to provide the fastest visual facade and thus, the most appropriate tool for the presentation in and out of the building. As a result, today's architects often think of materials as part of the design mix by which materials can be chosen and accepted as structure or combination or visual levels. It is in such a climate that many have reached the approach of smart materials.

3.7 SMART MATERIALS IN ARCHITECTURE

Smart materials are often investigated to achieve a rational development of the path of development and expansion of materials toward greater selection and specialization of the performance. For many years, an architect had to accept to work with standard materials such as stone

and wood and to design regarding the constraints of these materials, while during the twentieth century, he could have started to choose or manage the characteristics of high-performance material, especially to find the defined needs. Smart materials even grant additional specifications because their properties can be modified and thus respond to unsustainable needs. For instance, photochromic materials (with the spectral transport feature) change color when they are exposed to light. The entering light of the strongest surface area since the buildings are always confronted with changing conditions; the ability to respond to multiple states more than optimal in just one case has presented smart materials as a reviewable material for the design. As a result, we can start to find out many suggestions about how smart materials substitute for more common building materials (Mondal, 2008).

Although the cost and availability of conventional building materials are limited by smart materials, the implementation steps tend to follow the model that the new material has traditionally been introduced into the architecture, first through obvious examples (such as thermochromic materials and electrochromic doors), and then by fully distinguished proved projects, such as the Barasari restaurant, Diller Scofidio's work, and Seagram Building by Ludwig Mies van der Rohe (Figure 2). Many architects think that building surfaces and exterior walls and facades that are generally made of smart materials may automatically move their design from a lifeless box to an interactive corridor. Indeed, conditions such as variability and the interactive state have become the standard elements of the architect's dictionaries, as far as the technologies and necessary materials are superior to the practical and economic reality of most construction projects. For the inclusion of smart materials in a principled practice with conventional construction materials, the architects principally have tried to incorporate conventional standard building materials. Common standard building materials are immobile and tend to resist the forces of the building. Whereas, smart materials are dynamic so that they can respond to conditions in the fields of energy. With a smart material, we need to focus on what we want to do on that material, not on what we want it to look like. Recognizing smart materials needs to be a more simple and superficial understanding of material properties. There should also be a full and acceptable awareness of the underlying physical and chemical reactions of these materials with the environment surrounding it (Husseini, 2011).



Figure 2. The exterior view of the Seagram Building by Ludwig Mies van der Rohe.

3.8 REVIEWING THE PROPERTIES AND APPLICATION OF SMART MATERIALS CONCERNING ARCHITECTURAL NEEDS

One of the biggest problems in the use of smart materials in architectural design is that a limited number of materials and systems are under the influence of the same environmental effects, for example, the use of smart materials in controlling heat transfer via convection through building cover

may negatively affect the transit rate and influence of the light day. Furthermore, since the majority of the machines in the building have a high level of integration, it is difficult to optimize the performance of smart systems without affecting the system size or eliminating the balance of the control system (Arbabi and R'afati, 2012).

3.8.1 SAVING THE OPERATING COSTS OF SMART MATERIALS IN ARCHITECTURE

When asked about the cost of smart materials, all the architectural engineers and consultants can compute its cost. Anyway, the real price of smart materials is calculated from the volume of capital and the cost of building and setting it. The building value, the investment value, the value of executive activities is the highest volume of costs associated with smart materials, and since the building management systems greatly reduce operating costs, it not only will save money to the investor but also spend the lowest cost for construction (K.C.W).

3.9 ARCHITECTURAL DESIGN PLATFORM IN CONTEMPORARY TIMES

When the common claim is that architects design space, the fact is that they build surfaces. This particular advantage of surfaces causes the use of materials in two main directions. Second, since architecture is synonymous with the surface and materials of that surface, we inherently consider the materials as two-dimensional (i.e., two-level). The result is that we tend to consider materials in large 2D rows, i.e., outer covering, internal covering. More recent attempts to use smart materials in architectural design, the word '2D surface' or identity and a simple continuous purpose of smart materials are kept as substitutes or alternatives for many conventional materials. For example, many recommendations have been made to replace standard glass curtain walls or electrochromic glasses that completely cover the facade of the building (Golabchi, 2011).

3.10 THE EFFECT OF SMART MATERIALS ON GREEN BUILDINGS

ETFE environmental features

Energy consumption in the ETFE sheets production process is very low, and its full structure has a weight range 50-90% less than the similar structures made with other materials. It is comparable with other properties of weight. Structural systems, however, require more protection to maintain coverage. A part of the structure is made of recycled materials, and at the end of the life of each project, the entire system can be returned to the construction site for recycling. Long life-cycle and low construction and maintenance cost, makes ETFE a suitable solution in sustainable architecture. The architect of the structure can use the daylight and thermal cycle to change the features of the structure and function of the building. These capabilities and facilities make ETFE a unique group (Gorji and Aboutalebi, 2009).

Air dryers: Wind pumps can easily be equipped with air dryers to attract air moisture into the pads. This arrangement is recommended for high humidity environments (Gorji and Aboutalebi, 2009).

Fire: The ETFE sheet has a low combustion capability and is self-extinguishable. Pads evacuate the fire automatically in the event of fire because the mass of hot air causes the ETFE sheet to accumulate and recede from the heat source, thereby allowing the fire to exit. Since the amount of materials available in the roof is insignificant, molten sheet droplets do not fall during the fire (Gorji and Aboutalebi, 2009).

Acoustic: A sheet roof is relatively transient in terms of acoustic insulation, meaning that the

sheet acts as an acoustic absorbent for the room and increase the understanding of sounds in an internal environment (Gorji and Aboutalebi, 2009).

Heat insulation: The U-factor of a three-layered standard pad is equivalent to 1.96 kW/m, which is much higher than that of three glass layers when used horizontally (i.e., the glass producers present figures for the vertical glass that significantly increases the numbers). The characteristics of pads' insulation can be improved by adding self-covered layers (Gorji and Gorji, 1994).

Persistence: ETFE sheets are not affected by UV waves, environmental pollution, and atmospheric conditions. This material is tested both in the laboratory or in the outside environment; no erosion or resistance reduction was observed. ETFE sheets do not become fragile over time and do not lose color. This material is predicted to be more than 40 years old (Gorji and Aboutalebi, 2009).

Construct: The ETFE is built by a construct from steel frames, and no support structure is required. To achieve broader craters, the membrane can be reinforced by adding cables (Gorji and Aboutalebi, 2009).

The water, air, and water vapor insulation: The pads' material (i.e., Fluoropolymer sheets) alone acts like water, air, and water vapor insulation.

3.10.1 THE APPLICATION OF PHASE-CHANGE MATERIALS ON THE GREEN ROOF

Vegetation on the roofs, the green roof, is used as a passive technique to reduce buildings energy consumption and improve air quality around them. This is possible through the conservation of heat in winter and preventing direct sunlight and creating shade and cooling in summer. Control and management of surface water, energy conservation, reducing heat islands effect in cities, and increasing service life of roofs is one of the reasons for the importance of this issue. However, in most cases, the use of the green roof itself does not have a significant impact on energy consumption because storing nightly cold for daytime use and vice versa cannot save long-term heat from the sun at night. In this regard, the need for materials that can store thermal energy in the long run and significantly, among which are phase-change materials that improve the green roof efficiency by storing latent heat. By minimizing heat transfer in winter and creating shade and cooling in summer, the green roof leads to a reduction in the total heat load required for the building, and the addition of phase-change materials to the inner layer of the building increases these positive effects (Arbabi and R'afati, 2012).

3.10.2 GREEN ROOF'S THERMAL PERFORMANCE

The heat flux transfer of the green roof is controlled through four mechanisms:

1) Shading, 2) Thermal insulation, 3) Evapotranspiration, 4) Thermal mass

Overall, the total amount of radiation absorbed by the green roof is approximately reflected 22%, about 6% is absorbed by the evaporation of plants and soil, and only 13% is transferred to the soil (Sam C. M., 2009).

The thermal effects of the green roof can be divided into two aspects:

The direct effect on the building (i.e., the internal effect): In this case, the heat transfer problem is through the roof with the interior, which reduces the energy consumption of the building by reducing this heat exchange and preventing waste.

The indirect effect on the surrounding environment (i.e., the external effect): In this case, the heat transfer problem from the rooftop to the surrounding environment leads to the reduction of urban heat

islands and finally decreases the city's temperature, which will reduce the temperature reduction required for cooling to significantly reduce the energy conservation data. In calculating the thermal performance of the green roof, the type of vegetation, and the soil bed of the plant seem to have been affected by parameters (Torabi and Roshan, 2015).

4. CONCLUSION

Today, buildings are a form of technology; they adapt to technology and take advantage of it. Building as a structure, once it controls technology, becomes smart. The main purpose of using smart materials in a building is the storage of energy, proper and optimized utilization of facilities and the return of initial capital. Besides, considering the finitude of energy resources and the destructive effects of the immethodical consumption on the environment, we can also contribute to the global community, using new technologies, in reducing energy consumption. In the green building, using smart materials leads to reduced costs, which is much higher than the construction costs. It also reduces the adverse environmental effects and the approach of society towards sustainability criteria. Today's complex life, on the other hand, requires all these technologies, and on the other hand, it should try to maintain the environment and reduce energy consumption. Therefore, the methods described in this paper concerning the design and implementation of buildings are an effective step in reducing energy consumption in the building sector. Therefore, the reviewed examples in this study indicated that the facades should be better equipped and designed in such a way that they may be able to deal with the wind, rain, and humidity. Thus, the deployment of a method that does not create a limitation in addition to proper energy efficiency in the architectural design and building facade is considered one of the essentials in the design of buildings. In addition to taking positive points in the field of aesthetics, the ETFE panels' system has many unique capabilities, including thermal and acoustic insulation that plays an important role in reducing noise pollution. One of the most important systems studied in this research was phase-change materials which can save energy consumption by 20% if selecting its correct type, and in addition to natural ventilation, reduces the dependency of the building to the use of mechanical equipment.

From the outcomes of this study, the effective ways to reduce energy consumption in the building is the use of new construction materials and technologies are listed below:

Areas that new materials reduce energy consumption in construction:

- Optimization of existing materials and products
- Weight-loss and volume of materials and building elements (light-weighting)
- Reduction in the use of raw materials and energy
- Reduction of production steps/Reduction in the need to maintain and maintenance cost
- Increased speed of construction/ Dynamic economics
- Increased service life/Retrofit of buildings against earthquakes
- More efficient use of materials/Reduction of carbon dioxide emissions
- Prevention of damage/Conservation and preservation of natural resources
- Recycling capability/Plasticity
- More comfort

5. AVAILABILITY OF DATA AND MATERIAL

Data used or generated from this study is available upon request to the corresponding author.

6. REFERENCES

- Arbabi Yazdi, Amir, R'afati Seyyedi Yazdi, Mahdi (2012), "Smart materials and its impact on the creation of unique architecture," the first national conference for the permanent foundation, Mashhad.
- D. Zhou, C. Y. Zhao, and Y. Tian, "Review on thermal energy storage with phase change materials (PCMs) in building applications," *Applied Energy*, vol. 22, pp. - 065 523, .2012
- Sam C. M. Hui. Final Report Study of Thermal and Energy Performance of Green Roof Systems. University of Hong Kong. 2009.
- Golabchi, M., Taqizadeh, K., Soroush, E. (2011). Smart materials and new Technologies for the architecture and design professions. Architectural press. 63-91
- Gorji Mehlabani, Yosef, Haj Aboutalebi, Elnaz. (2009), "Smart materials and their role in architecture," *Housing and Village Environment Quarterly*, 127, 66-81.
- Husseini, L. (2011), "Sustainability in architecture," series of articles of the first climate forum, building, and optimization of energy consumption, Tehran.
- K.C.W. Ip, "Solar thermal storage with phase change materials in domestic buildings"
- Kasmaee, M. (2012), "Climate and architecture," the Iranian building investment company.
- Keikha, H. (2018), "The design of a residential complex in Yazd with a zero-energy approach (i.e., sustainable), a master's degree thesis, Islamic Azad University of Zahedan.
- Kiomarsi, V., Ahmadipour, F. (2001). Smart architecture. A Master's degree thesis, Tehran: Shahid Beheshti University.
- Kienzl, M.N., Schodek, D. (2002). Smart Materials and Technologies in Architecture. School Design; Harvard Desing.
- Ritter, Axel, (2004)."Smart Materials in Architecture, Interior Architecture, and Design ", Birkhauser, Switzerland.
- S. Mondal, "Phase change materials for smart textiles – an overview", *Applied Thermal Engineering*, V.28 (2008), N. 11-12, P. 1536-1550. Architecture and building engineering," University of Tehran.
- Saanei, Mohammad Javad, Masudi Far, Payam (2008), "Smart materials," first inter-element meeting of new technologies in the field of the construction industry; 71 - 90.
- Torabi, H., Roshan, M. (2015). "The application of smart materials in the architecture of green buildings," the series of articles of the first annual conference of architectural research, urban and urban management.
- Turkgizi, M., Farokhzad, M. (2013). "The application of solar systems in the building: a new solution to optimization of energy consumption," the second international conference for modern approaches to energy conservation.



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SEGMENTAL LINING GROUT SOLUTIONS FOR THE CONSTRUCTION OF TUNNELS AND MINING GALLERIES

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ABSTRACT

The article deals with the selection of the composition of cement slurries for the construction of mine workings with concrete lining and high-precision segment lining. When using cement slurries to fill the space between the lining and the rock containing the mining output, the solution prepared from locally available materials may not meet the requirements, and the use of imported ready-mixed mixtures will be unacceptably expensive. Optimization of application modes of cement slurries in the construction of tunnels with a segment lining to increase the reliability of powerful and high-performance equipment. Systematization of the theory and practice of building tunnels with high-precision lining using mechanized tunneling complexes. Mathematical descriptions of the processes, experimental modeling of the obtained dependencies, and emergencies associated with the preparation of cement slurries are systematized. A description of the rheology of the cement slurry in the process of lining and the mechanism of the solution-rock mass system is given. The results of the experiment on the reinforcement of cement and lime cement slurries are given. The expediency of the solution reinforcement was confirmed not only for the formation of thixotropic properties but also for the maintenance of suspension. The results of a critical assessment of the components of cement slurries in relation to their use in mechanized tunnel complexes are given. The parameters for the preparation and use of mixtures should be selected on the basis of the results of comprehensive studies in specific conditions. The quality of preparation of the cement mixture in a complex increases the efficiency of the use of mechanized tunnel complexes.

Disciplinary: Tunnel Engineering, Concrete/Cement Technology.

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1. INTRODUCTION

During preparation for tunnel construction, a set of factors are taken into account, including the choice of penetration technology, the possibility of penetration and mine construction and its infrastructure provision with materials and transport, the safety conditions of the enclosing massifs and the earth surface, etc. An underestimation of the importance of these factors leads to abnormal emergencies (Atrushkevichm & Atrushkevich, 2014; Adibi et al, 2015).

One of the most important issues is the type and the properties of grouts for filling the space between the lining and the ground. The grout prepared from scrap materials may not meet the requirements or be very expensive due to the use of imported ready-made mixtures and insufficient use of local ingredients (Galaov et al, 2014).

The rate of penetration largely depends on the quality and composition of grouts; therefore, the goal of the study in this area and this work is to optimize the use of grouts in the construction of tunnels with a segment lining (Kissin et al, 2017; Budach, 2010).

2. STUDY METHOD

To create a database, information is systematized on the construction of tunnels with high-precision lining and a detailed theory and practice of segmental lining using mechanized tunneling complexes with grouts. The analysis is accompanied by the mathematical description of technological processes. In order to check the correctness of the obtained models, experimental reinforcement of cement and lime grouts is carried out. Based on the obtained dependencies, recommendations are given on the practical implementation of the proposed technology.

3. RESULTS

Grouts for the construction of tunnels with high-precision lining perform the following functions:

- distribution of ground and hydrostatic stresses;
- preservation of the form and development stability;
- waterproofing and prevention of concrete natural leaching.

When they develop tunnel construction projects, the depth conditions, tectonics, petrographic and mineralogical composition, fractures and the nature of rock fracture substitution are taken into account.

During the construction of tunnels with segmental lining and the use of mechanized tunneling complexes, not only the properties of the cement stone are taken into account, but also its mobility during the required time.

This is due to the fact that the solution enters the system of the tunnel complex using the system of pumps with certain characteristics, including rheological parameters. The most common problems associated with the use of grouts are summarized in Table 1.

The tunnel cementation program includes the following steps:

- 1) selection of mixture components and their preparation parameters;
- 2) experimental verification under actual penetration conditions and recipe adjustment;
- 3) grout quality control during use.

Table 1. Emergency situations associated with grout preparation

Cause	Problem	Solution
Fractions of more than 0.7 mm in grout composition: pebbles or small stones	The failure of pump cuffs and sleeves. Abrasive wear. Failure of rubber couplings. The failure of pump rubber parts. Channel-lock.	Replacement of pump parts, flushing of pumps and channels. Sift the solution through a sieve, use fine sand.
High water loss coefficient (over 200×10^{-3} (min)-1/2)	Pumps squeeze out water from the grout under pressure. The dry mixture remains in the channels. The discharge pressure is higher than the groundwater pressure; the free water falls inside the shield under pressure. The conditions for the formation of high-quality cement stone deteriorate.	Flush pumps and channels from the dry fraction. Use special additives to reduce water loss. The more granulometric composition of the components, the easier to "squeeze" water from the grout.
Fast setting time of the grout (less than 6 hours)	The grout hardening at various stages of its delivery into the annular space leads to the blocking of channels and the failure of pumps. Downtime is inevitable, and the service life of the pumps is reduced.	Provide for the availability of spare channels for pumping the grout in the complex. Use mineral or organic setting retarders.
The rheological properties of grout do not provide their mobility.	There is not enough pump power, they are switched off by current, increased wear of equipment, increased energy consumption. Increased discharge pressure, too much pressure on the ring, ring "folding", a traumatic situation.	Use plasticizers, control the discharge pressure according to the ring strength condition.
Long sitting time (over 14 hours)	Uneven distribution of grout in the tunnel, the displacement of the tunnel axis upwards (with the rod ascent) or downwards.	Retarder amount control. Caution when you work with salts. The use of organic retarders.

The grout rheology is characterized by structural (apparent) viscosity, cohesive strength, and internal friction. The behavior of the Newtonian fluid and the suspension of Bingham is characterized by Figure 1.

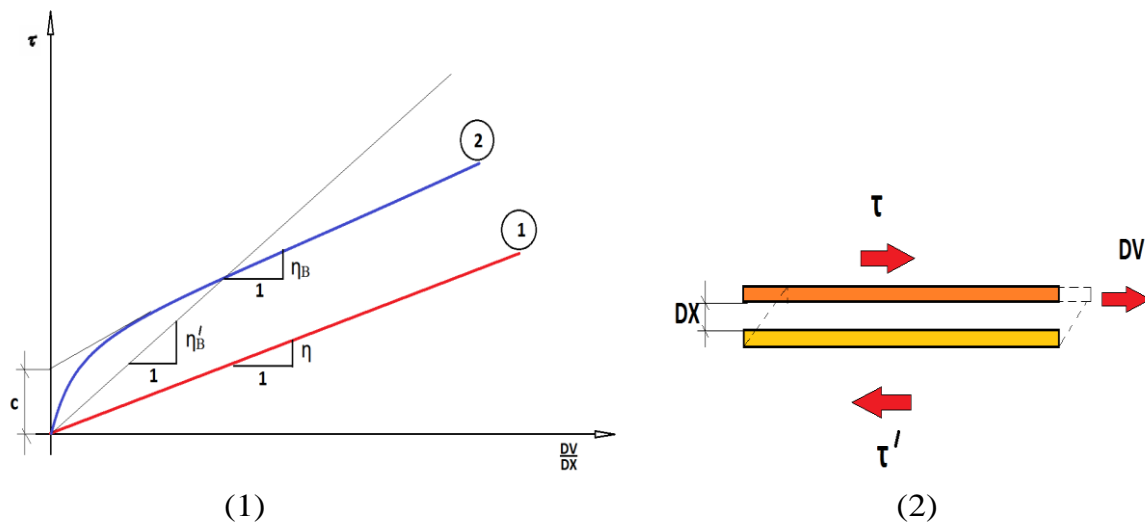
**Figure 1:** The rheology of Newtonian fluid (1) and Bingham solution (2).

Figure 1, the upper diagram determines the viscosity property difference between the liquid and the grout. The bottom diagram defines the shear properties of the solution. The viscosity of the mixture is directly proportional to the shear resistance and inversely proportional to the grout shear rate:

$$g = (V_2 - V_1) / dx \text{ (sec}^{-1}\text{)} \quad (1),$$

Where

g — the shear rate, sec^{-1} ;

V_2 – the lower layer speed, m/s;

V_1 – the upper layer speed, m/s;

dx – the distance between the layers, m.

The equation for the curve 1:

$$\tau = \eta \times DV / DX \quad (2).$$

The equation for the curve 2:

$$\tau = C + \eta_b \times DV / DX \approx \eta' \times DV / DX \quad (3),$$

where η is the dynamic viscosity;

η_b is plastic viscosity;

η' is structural viscosity;

C - cohesive strength.

These math models of state are derived without taking into account internal friction. Cohesive strength corresponds to shear strength. In the case of a Newtonian fluid, the cohesive strength makes zero, and the plastic and structural viscosity have the same magnitude, which is the dynamic viscosity.

Figure 2 illustrates the behavior of the grout with regard to internal friction and shear resistance, which varies with the fluid pressure.

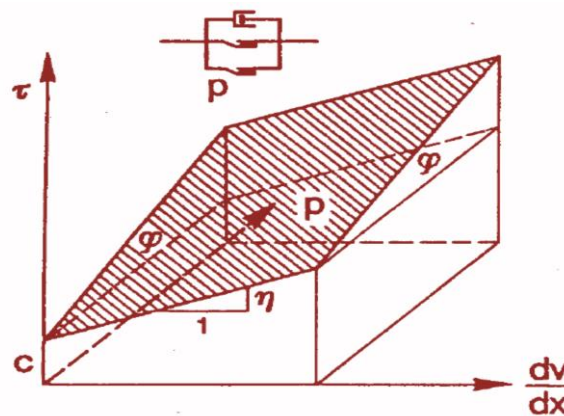


Figure 2: Suspension properties with regard to internal friction.

$$\tau = C + \eta_b \times DV / DX + p \times \tan \phi \quad (4),$$

where p - pressure;

$\tan \phi$ - the tangent angle of grout internal friction.

The unstable grout behaves as a Newtonian fluid, or as Bingham suspension with internal friction. The grout with significant internal friction is difficult to deliver to the annulus. Cohesive strength indicates how deeply the grout penetrates the hole of a certain radius under a certain pressure, while viscosity determines the flow rate of a stream under a certain pressure.

Low viscosity ensures the grout, coarse sand or weakly fractured rock penetration into the soil with small pores.

The high cohesive strength of the grout is not a disadvantage since there is no task to penetrate into the soil (Jarvie-Eggart, 2015).

During the selection of grout thixotropic properties, one should strive to ensure that the grout

becomes less viscous and lose some of its strength during pumping, and when it is stopped in the annular space, it gains maximum strength. This can be achieved by using polymer reinforcement of the grout with the chains of long polymer molecules.

We carried out the experiment on the reinforcement of cement and lime grouts in the laboratory. The grout components and the polymers were mixed in the water separately. Thus the thixotropic properties of the grout improved dramatically. The water loss coefficient decreased by more than 10 times, and there was practically no water distribution. It has been established that it is impractical to apply salt retarders in polymer reinforcement of the grout. Instead of mineral retarders, it is recommended to use organic polymer retarders, which creates significant savings.

Experimentally obtained side effect of polymer component interaction: in the absence of turbulence (without stirring), the filtration of water into the solution slowed down. This has a positive effect on the quality of cement stone when sinking in severely watered conditions.

The grout reinforcement is necessary not only for the formation of thixotropic properties but also to maintain suspension. It is important to prevent the formation of sludge in the pipes and pumps of the tunnel complex at the time of stopping during ring mounting. If the installation of one ring will take 3-4 hours, and the freezing time of the solution is 6 hours, with round-the-clock penetration, you will not have to waste time washing the pumps and channels. They will be cleaned in the following portions of the solution. Figure 3 shows the maintaining cement by using polymer reinforcement of the grout with the chains of long polymer molecules in practical. Figure 4 shows a tunnel needing maintenance.



Figure 3: Grouting application using the chains of long polymer molecules reinforcement.



Figure 4: Tunnel maintenance

The first step after tunnel drilling is to control the tunnel stability to ensure the safety required during drilling and their long-term stability. In general, the Earth is under natural, gravity and tectonic forces. As a result of tunnel excavation, the balance between these forces is disrupted and a new stress situation is created which may cause the ground around the tunnel to break down.

The main part of the solution is not cement, but a mineral binding filler, for example, fly ash or slag flour. The amount of sand is reduced, which positively affects the rheological properties without reducing the cement stone strength.

The solution with increased mobility must include a sufficient number of small particles in order to maintain the properties of the gel, stability under pressure and gain strength over a certain period of time. The use of a water-cement ratio of more than 1.5 leads to loss of stability and increased water loss and water separation. Using a 0.45 ratio increases equipment wear.

For the manufacture of highly mobile grouts they use Portland cement, which is classified by the following types (Golik et al, 2018; Golik et al, 2016):

- 1) in the absence of specific requirements and special technical restrictions;
- 2) for resistance to sulfate components of soil and water and upon presentation of special requirements for the cement crystallization temperature;
- 3) to increase the strength properties in two-component solution quickly for the creation of mixtures penetrating into microcracks;
- 4) It produces less heat than type 2 when it hardens and gains strength slower than type 1, and it is used to move large masses of cement and high temperatures if necessary;
- 5) with increased sulfate exposure.

Plasticizers, for example, naphthalene sulfonate, lignosulfonate and melamine-based materials transfer a negative charge to each cement particle, the particles repel each other. The use of these substances reduces the viscosity of the solution since the distance between the cement particles is increased and the structure-forming components penetrate between them. The strength of the resulting sample may be higher. The traditional proportion is from 0.5% to 2% of cement weight. Lingosulphates slow down the crystallization process.

Bentonite powder stabilizes the mobile solution, increases its mobility and reduces filtration resistance, increasing the viscosity, but reduces the strength of the cement stone. Magnesium bentonite type of Wyoming powder is recommended. Adding bentonite to the cement mixture increases its viscosity and can create problems with the mixer. However, upon further stirring, the viscosity of the solution decreases, because negatively charged particles of bentonite are attracted to positively charged particles of cement. Bentonite is shut in water for 12 hours prior to mixing, or a pump-mixing unit is used. No more than 5% of bentonite of cement weight is added due to the stone strength reduction.

Fly ash - pozzolanic mineral components that improve the distribution of particles in the solution, reduce water loss and increase the stability of the solution. Ashes go well with lime mortars and cement substitutes. When they use type C ash with more than 20% of cement weight, there are problems with mortar stability.

Sand dust, for example, ground sand with the size of less than 1 micron improves the structural properties of the solution and the distribution of particles in it when less than 10% of cement weight is used.

Organic resins are the additives that improve the thixotropic properties of the solution and reduce filtration and hydration. Proportions are highly dependent on the presence of other components and their chemical composition, the pH of water and mortar, soil, and usually make up 0.1 - 0.2% of cement weight.

Organic washout additives, for example, poly cellulose molecules reduce water separation and filtration, improving rheological properties. Some of them are not compatible with naphthalene sulfonate polymers and are limited for use with exopolysaccharides. The proportion makes from 0.2 to 1% of cement weight.

Stabilizers and accelerators are used most often in two-component solutions. The stabilizer coats the cement particles and prevents it from hardening for 72 hours. After that, accelerators are added to the solution and the accelerated crystallization process begins. Calcium chloride or sodium silicate is added to water and its amount makes no more than 20% of cement weight, given that the reaction occurs with the release of a large amount of heat.

4. CONCLUSION

The design of the cementing process is an important step for tunnel construction preparation, where errors are accompanied by a significant increase in work cost and penetration rate slowdown. The parameters for the preparation and the use of mixtures are selected according to the results of laboratory and field tests. A simple tunnel complex with a diameter of 4 meters costs more than 30 thousand euros per day, and larger diameter is several times larger, so the error causes large losses.

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding authors

6. REFERENCES

- Adibi, N., Ataee-pour, M., & Rahmanpour, M. (2015). Integration of sustainable development concepts in open pit mine design. *Journal of Cleaner Production*, 108, 1037-1049.
- Atrushkevich V. A., & Atrushkevich, A. V. (2014). Development of integrated technical systems of mining enterprises. *Gornyj informacionno-analiticheskij byulleten'*, 1, 368-365. [In Russ]
- Budach, C. (2010). Neue Untersuchungen zur Konditionierung von Lockergesteinen bei Erddruckschilden. *FELSBAUMAGAZIN*, (5).
- Galaov, R. B., Nagovitsin, Yu. N., Pliev, B. Z., Andreev, A. A., & Vilchinsky, V. B. (2014). Improving the methods of fixing workings in the mines of the ZF of OJSC MMC Norilsk Nickel. *Gornyi Zhurnal*, 4, 25-28. [In Russ]
- Golik, V. I., Dmitrak, Yu. V., Maksimov, R. N., & Lyashenko, Yu. M. (2018). Use of ore dressing tailings in hardening mixtures. *Gornyj informacionno-analiticheskij byulleten'. Special'nyj vypusk*, 6, 56-64. [In Russ]
- Golik, V. I., Lyashenko, V. I., & Lukyanov, V. G. (2016). Artificial ceramics in underground mining of ores. *Ustojchivoe razvitie gornyh territorij*, 3, 248-255. [In Russ]
- Jarvie-Eggart, M. E. (2015). Responsible Mining: Risk Management in the Developed World. *Englewood. - Colorado. - Society for Mining, Metallurgy and Exploration*, 804 p.
- Kissin, A., Tomilina, A., & Komashchenko, V. (2017). Roads of the Southern Ural mountains. *Earth Science Frontiers*, 1-8.



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RELATIONSHIP BETWEEN CLASSROOM ORGANIZATIONAL SKILLS AND PROFESSIONAL ATTITUDE OF PRIMARY SCHOOLS TEACHERS AND HEAD TEACHERS REGARDING STUDENTS' MOTIVATION IN DISTRICT D.I.KHAN

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ABSTRACT

This study focused on classroom organizational skills and the professional attitude of teachers and head teachers as well as students' motivation at Primary school level. The population of the study comprised of all Public and Private Primary Schools teachers and head teachers in district D.I.Khan. With, random sampling, the total 179 respondents were Primary Schools teachers and 54 Primary Schools head teachers). The key purpose was to investigate the relationship between classroom organizational skills and professional attitude of Primary school teachers and head teachers regarding students' motivation in district D.I.Khan. The study was delimited to all-male Public and Private school teachers and head teachers in district D.I.Khan. Three points Likert scale "Yes, No, To Some Extent" was used for the purpose of data collection from the respondents. Data were analyzed through the Chi-Square Online Calculator by using P-value and Chi-Square. The attitudes and organizational skills of professional teachers and head teachers are the key factors and tools to positively motivate their students for better and quality education.

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1. INTRODUCTION

A classroom management system helps students to enhance positive classroom behavior, organizational skills, and study routine or pattern; it's the responsibility of the teacher to maintain classroom environment predictably and in the proper order to motivate students towards learning (Silins & Mulford, 2002). Quality teachers are better classroom organizers to run classroom activities smoothly and maintain discipline in the classroom for ensuring the quality of education and motivating students for quality learning (Saraswat, 1976). Organization means all students in the proper place at the proper time and also to encourage regularity, punctuality, accuracy, perseverance and quality in all activities of students (Ruzek et al., 2014). Learning and academic achievement can

be attained if proper classroom organizational skills are implemented in the classroom and students' interest in learning has been ensured through multi-motivational techniques in the classroom. Classroom disruption may be stopped if an effective organizational system is functional in the institution and students are properly motivated to learn (Reeve, 2006). Classroom management, classroom organization and students' achievement are interrelated for which students' motivation is quite mandatory and essential to easily attain the goal (Reardon, 2011). Students' guidance, observation, and educational activities are easily tackled through motivation, managerial and organizational skills (Quigney, 2000). Motivational and Effective teachers technically organize and manage their classrooms in productive and positive manners (Pashiardis et al., 2005).

The classroom organization focuses mainly on the physical environment. Effective teachers are aware of organizational expertise. They organize a safe classroom environment by motivating students to optimize and positively enhance students' learning (Monahan, Ognibene & Torrisi, 2000). Effective teachers know that student's behavior in the classroom for which they motivate students to show better performance as they can. They are of the view that the key factor behind the students' development is that how they behave and perceive their environment which is possible through proper motivation and implementation of organizational skills in all classroom activities for better results (Nir & Hameiri, 2014). Motivation is highly essential for classroom organization and classroom management; classroom organization includes location of classroom materials, furniture arrangements and displays well organized and effective teachers decorate the classroom with students' work for which teachers' interest and students' motivations as well as their interest are ought adopt and follow (Luckner & Pianta, 2011).

2. LITERATURE REVIEW

Attending multi trials and issues regarding classroom organization and classroom management provide a base with high expectations for students' behaviors (Leite, 1994). Classroom teachers are classroom managers because they organize and motivate their students in the classroom and play a key role in motivating and managing learning activities of students, their attitudes and feelings in their classroom, so classroom management along with students' motivation is directly associated with teachers' abilities to deliver their lectures in the classroom in order to easily get the desired goals (Lapointe, Poirel & Brassard, 2013). Teachers having organizational expertise and motivational techniques ensure a quality learning atmosphere among students through their proper feedback, better communication, coordination, loving and positive behavior, discipline and motivational nature (Kimball, 2011). Attitude is a relational mental state which directs individuals' behavior (Jackson & Marriott, 2012). The manifestation of professionalism is basically an attitude (Harrison, Newman & Roth, 2006).

Professionals care, motivate, respect and train others to work fraternally and sincerely anywhere whether in any institution or organization (Gurr, Drysdale & Mulford, 2005). They always motivate students and show disciplined behaviors during their lectures in the classroom as true professionals. There is a profound effect on teachers' motivation, perceptions, beliefs, and experiences on their teaching practices and students' interest to learn. Therefore, a positive attitude and motivation are the key factors to be included in teachers' personalities (Grissom & Loeb, 2011). The attitude of a teacher and motivation has clear impacts on students' learning performance and academic achievement whether his attitude and motivation are positive or negative (Griffith, 2006). Teachers' motivation

along with quality education is highly essential to face the challenges of the day in this modern world and students, their parents, as well as the community members, expect quality education which is possible only through quality talented and sincere professional teachers (Gregory et al., 2014). Teachers with loving and positive attitudes encourage their students to learn more and more. They proved their students' proper feedback. Time management, better planning, balanced and clear conversation, respect as well as care of other students are the main characteristics of successful professional teachers to practically follow and implement it on the basis of their positive, polished and polite attitude (Green & Cooper, 2012).

Teachers' professional attitude plays a vital role in their interaction with students, their parents, staff and community members (GCPI, 1981). They technically motivate their students towards quality learning and other curricular as well as co-curricular activities through their better polite and loving professional attitudes (Gambill, Moss & Vescogni, 2008). The professional attitude of a teacher has a magnetic power to attract and control his/her students spiritually, socially, morally and psychology to always follow the right path a true sense (Furney et al., 2005). There is a crucial role of teachers' professional attitudes in their students' better learning and academic activities either to attain their ultimate goals or to lose it (Feigenbaum & Feigenbaum, 2003). Head Teacher is the man who runs all administrative activities in his school and motivates all faculty members as well as students in order to fulfill the organizational goals (Desimone, 2009). The best Head Teacher successfully supervises all matters related to the institution to attain the desired administrative objectives by motivating all the employees attached to his institution (Crum, Sherman & Myran, 2010). The Head Teacher properly interprets school-based policies and procedures on the basis of his motivational power, better managerial and administrative skills as well as his experiences. Professional Head Teacher always follows the discipline and openly discourages school-related problems like noise-making, absenteeism, naughtiness, restlessness, disobedience, fighting, rudeness, boredom, truancy, sleeping, inattention, refusal of assignments and untidiness. He always motivates his students to work hard all the time so that they may easily get the desired goal (Crum & Sherman, 2008).

Professional Head Teachers with organizational expertise and motivational capabilities at school level highly develop the institution and such type of Head Teachers positively and technically interact with the community members including parents, teachers and students surrounding the school (Chan & Jarman, 2004). It is quite mandatory for all well-organized Head Teachers to be fully aware of leadership and problem solving as well as communication skills to smoothly run and functionalize all matters and educational activities pertaining to school/institution (Brief & Weiss, 2002). Highly professional Head Teachers are highly visionary and motivational personalities. Professional and motivational Head Teachers are better and patient listeners and they have true leadership qualities. They build the future of their students through motivation toward learning. They are instructional leaders by taking too many responsibilities for the success and betterment of their school teachers, students and administrative staff of their schools (Boller, 2008).

Professional Head Teachers are varying in leadership style, temperament and strategy; despite their administrative responsibilities, they lead teaching as well as learning (Bakunas & Holley, 2004). Professional Head Teachers always motivate their teaching and non-teaching staff members and create positive culture and always think of their long term planning for their students' academic

enhancement and success (Arnn & Mangieri, 1988). Professional Head Teachers cultivate leadership in students; they motivate students for better future and assess teaching methodology, develop involvement and monitor students' achievement on the basis of their professional talent and skills (Arlestig, 2008). Professional Head Teachers assess teaching methodology of teachers; develop standardized curricula; they encourage parental involvement and monitor students' learning and academic achievement (Akins et al., 2013). Professional Head Teachers properly administer budget, revise procedures and policies at school level. Professional Head Teachers technically hire staff members; evaluate all activities of school including teachers' teaching and students' learning (Agho, 2009). Professional Head Teachers are highly respectful; they are sensible decision makers and they positively interact with students and teachers. They are foundations of their schools (Gregory et al., 2014).

2.3 HYPOTHESIS OF THE STUDY

The following hypotheses were tested:

- There is a significant relationship exists between classroom organization skills and professional attitude of Primary Schools teachers regarding students' motivation in district D.I.Khan.
- There is a significant relationship exists between classroom organization skills and professional attitude of Primary Schools head teachers and head teachers regarding students' motivation in district D.I.Khan.

3 RESEARCH METHODOLOGY

The study was descriptive in nature. The population of the study in Table 1 included all male Primary schools' teachers and head teachers in district Dera Ismail Khan as shown in Table 1.

Table 1: Population of the Research Study

Primary Schools	Teacher	Head Teacher	N
Public	2693	713	3406
Private	900	360	1260
Total	3593	1073	4666

Out of population (N=4666), sample size was taken at 5%, thus n = 233 was selected from Public and Private Primary schools teachers and head teachers in which 179 respondents were teachers and 54 respondents were head teachers in district D.I.Khan. The detail is shown in Table. 2.

Table 2: Sample of the Research Study

Primary School	Teacher	Head Teacher	n
Government	134	36	170
Private	45	18	63
Total	179	54	233

A questionnaire of three points scale having options "Yes, "To Some Extent" and No" carrying values 3, 2 and 1 was used for data collection from the respondents.

3. RESULTS AND DISCUSSION

Regarding this research work, the suitable statistic was Chi-square statistics, correlation and p-value to calculate the results for the purpose of research.

Table 3: Relationship between Classroom Organizational Skills and Professional Attitude of Teachers Regarding Students' Motivation.

Schools	Professional Attitude	Classroom Organization Skill Students' Motivation			N	χ^2 calculated	R ²	P-value
		Yes	To Some Extent	No				
Public	Good.	60	15	05	80	63.722	0.73	<0.001
	Normal.	20	12	02	34			
	Poor.	02	03	15	20			
	N	82	30	22	134			
Private	Good.	20	04	01	25	20.283	0.71	<0.001
	Normal.	09	04	02	15			
	Poor.	0	01	04	05			
	N	29	09	07	45			

Table 3 shows the Chi-Square value of association between the professional attitude of a teacher and classroom organizational skills of Public and Private schools at the Primary level that was found 63.722 for Public and 20.283 for Private schools. As χ^2 calculated value is higher than χ^2 tabulated value which is 9.488, it reveals that there exists a significant relationship between classroom organizational skill and professional attitude of teachers at Public and Private school at primary level regarding student's motivation.

As 0.73 and 0.71 are the correlation values of these two variables showing higher positive association between classroom organizational skills and students' motivation while the p-values 0.05 more than <0.001 and <0.001, it shows the significant link between Teachers' motivation to students' along with professional attitude as well as classroom organizational skills of Public and Private Primary schools teachers.

Table 4: Relationship between Classroom Organizational Skills and Professional Attitude of Head Teachers Regarding Students' Motivation

Schools	Professional Attitude	Classroom Organization Skill Students' Motivation.			N	χ^2 Calculated	R ²	P-value
		Yes	To Some Extent	No				
Public	Good.	16	04	02	22	12.157	0.79	0.0162
	Normal.	07	02	01	10			
	Poor.	00	01	03	04			
	N	23	07	06	36			
Private	Good.	09	01	00	10	13.569	0.78	0.0088
	Normal.	03	02	00	05			
	Poor.	01	00	02	03			
	N	12	03	03	18			

Table 4 shows the Chi-Square value of association between the professional attitude of a head teacher and classroom organizational skills of Public and Private schools at Primary level that was found 12.157 for Public and 13.569 for Private schools. As χ^2 calculated value is higher than χ^2 tabulated value which is 9.488, it reveals that there exists a significant relationship between classroom organizational skill and professional attitude of head teachers at Public and Private primary schools regarding student's motivation in district D.I.Khan.

As 0.79 and 0.78 are the correlation values of these two variables showing higher positive association between classroom organizational skills and students' motivation while the p-values 0.05>0.0162 and 0.0088 it shows the significant link between head teachers' motivation to students along with professional attitude as well as classroom organizational skills of Public and Private

Primary schools head teachers.

4. CONCLUSION

It is concluded that the association between professional attitudes and classroom organizational skills of head teachers and teachers exists in Public and Private Schools at the primary level in district D.I.Khan. It is found that the attitudes and organizational skills of professional teachers and head teachers are the key factors and tools to positively motivate their students for better and quality education. Therefore, positive attitudes and organizational skills are ought to be implemented in the classroom by their professional head teachers and teachers. Primary school teachers should be professionally trained in this regard. Primary school teachers should attend special seminars and workshops about professional attitude and organizational skills at the primary level.

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

6. REFERENCES

- Agho, A. O. (2009). Perspectives of Senior-Level Executives on Effective Followership and Leadership. *Journal of Leadership & Organizational Studies*, 16, 159-166.
- Akins, R., Bright, B., Brunson, T., & Wortham, W. (2013). Effective Leadership for Sustainable Development. *Journal of Organizational Learning & Leadership*, 11(1), 29-36.
- Arlestig, H. (2008). Structural Prerequisites for Principals' and Teachers' Communication about Teaching and Learning Issues. *Improving Schools*, 11(3), 189-203.
- Arnn, J. W., & Mangieri, J. N. (1988). Effective Leadership for Effective Schools: A Survey of Principal Attitudes. *NASSP Bulletin*, 72(505), 1-7.
- Bakunas, B., & Holley, W. (2004). Teaching Organizational Skills. *The Clearing House*, 77(3), 92-5.
- Boller, B. (2008). Teaching Organizational Skills in Middle School: Moving Toward Independence. *The Clearing House*, 81, 169-171.
- Brief, A. P., & Weiss, H. M. (2002). Organizational Behavior: Affect in the Workplace. *Annual Review of Psychology*, 53, 279-307.
- Chan, T. C., & Jarman, D. (2004). Departmentalize Elementary Schools. Principal, *Educational Researcher*, 84(1), 70-72.
- Crum, K. S., & Sherman, W. H. (2008). Facilitating High Achievement: High School Principals' Reflections on Their Successful Leadership Practices. *Journal of Educational Administration*, 46(5), 562-580.
- Crum, K. S., Sherman, W. H., & Myran, S. (2010). Best Practices of Successful Elementary School Leaders. *Journal of Educational Administration*, 48(1), 48-63.
- Desimone, L.M. (2009). Improving Impact Studies Of Teachers' Professional Development: toward Better Conceptualizations and Measures. *Educational Researcher*, 38(3), 181-199.
- Feigenbaum, A. V., & Feigenbaum, D. S. (2003). Quality, Not Quantity, of Management. *Quality Progress*, 36(10), 44-48.
- Furney, K. S., Aiken, J., Hasazi, S., & Clark/Keefe, K. (2005). Meeting the Needs of All Students: Contributions of Effective School Leaders. *Journal of School Leadership*, 15(5), 546-570.
- Gambill, J.M., Moss, L.A., & Vescogni, C.D. (2008). *The Impact of Study Skill and Organizational Methods on Student Achievement*. Retrieved from ERIC database. (ED 501312).

- GCPI. (1981). *A study of relationship of academic achievement with attitude towards teaching among teacher trainees*, Allahabad.
- Green, R. L., & Cooper, T. (2012). An Identification of the Most Preferred Dispositions of Effective School Leaders. *National Forum of Applied Educational Research Journal*, 26(1/2), 55-76.
- Gregory, A., Allen, J. P., Mikami, A. Y., Hafen, C. A., & Pianta, R. C. (2014). Effects of a Professional Development Program on Behavioral Engagement of Students in Middle and High School. *Psychology in the Schools*, 51(2), 143-163.
- Griffith, J. (2006). A Compositional Analysis of the Organizational Climate-Performance Relation: Public Schools as Organizations. *Journal of Applied Social Psychology*, 36, 1848-1880.
- Grissom, J. A., & Loeb, S. (2011). Triangulating Principal Effectiveness: How Perspectives of Parents, Teachers, and Assistant Principals Identify the Central Importance of Managerial Skills. *American Educational Research Journal*, 48(5), 1091-1123.
- Grissom, J. A., & Loeb, S. (2011). Triangulating Principal Effectiveness: How Perspectives of Parents, Teachers, and Assistant Principals Identify the Central Importance of Managerial Skills. *American Educational Research Journal*, 48(5), 1091-1123.
- Gurr, D., Drysdale, L., & Mulford, B. (2005). Successful Principal Leadership: Australian Case Studies. *Journal of Educational Administration*, 43(6), 539-551.
- Harrison, D. A., Newman, D. A., & Roth, P. L. (2006). How Important Are Job Attitudes? Meta-Analytic Comparison of Integrative Behavioral Outcomes and Time Sequences. *Academy of Management Journal*, 49, 305- 325.
- Jackson, K. M., & Marriott, C. (2012). The Interaction of Principal and Teacher Instructional Influence as a Measure of Leadership as an Organizational Quality. *Educational Administration Quarterly*, 48(2), 230-258.
- Kimball, S. M. (2011). Principals: Human Capital Managers at Every School. *Phi Delta Kappan*, 92(7), 13-18.
- Lapointe, P., Poirel, E., & Brassard, A. (2013). Beliefs and Responsibilities of Educational Stakeholders Concerning Student Success and Effective Principal Leadership. *Canadian Journal of Educational Administration & Policy* (142), 33-49.
- Leite, A.F. (1994). In: Affizal Ahmad & Rafidah Sahak. (2009). Teacher-Student Attachment and Teachers' Attitudes towards Work, *Journal Pendidikan Den Pendidikan, Jilid*, 24, 55-72.
- Luckner, A. E., & Pianta, R. C. (2011). Teacher-Student Interactions in Fifth Grade Classrooms: Relations with Children's Peer Behavior. *Journal of Applied Developmental Psychology*, 32(5), 257-266.
- Monahan, S., Ognibene, B., & Torrisi, A. (2000). *Effects of teaching organizational strategies*. Retrieved from ERIC database. (ED 450941)
- Nir, A. E., & Hameiri, L. (2014). School Principals' Leadership Style and School Outcomes the Mediating Effect of Powerbase Utilization. *Journal of Educational Administration*, 52(2), 210-227.
- Pashiardis, P., Costa, J. A., Mendes, A. N., & Ventura, A. (2005). The Perceptions of the Principal versus the Perceptions of the Teachers: A Case Study from Portugal. *International Journal of Educational Management*, 19(7), 587-604.
- Quigney, T. A. (2000). Effective School Administration in an Age of Educational Reform. *Mid-Western Educational Researcher*, 13(4), 21-27.
- Reardon, R. M. (2011). Elementary School Principals' Learning-Centered Leadership and Educational Outcomes: Implications for Principals' Professional Development. *Leadership and Policy in Schools*, 10(1), 63-83.
- Reeve, J. (2006). Teachers As Facilitators: What Autonomy-Supportive Teachers Do and Why Their Students Benefit. *The Elementary School Journal*, 106(3), 225-236,
- Ruzek, E. A., Domina, T., Conley, A. M., Duncan, G.J., & Karabenick, S. A. (2014). Using Value-Added

Models To Measure Teacher Effects on Students' Motivation and Achievement. *The Journal of Early Adolescence*, 1-31

Saraswat, R.M. (1976). *A Study of Attitude of Trained High School Teachers of Aligarh towards Their Professional Training and the Students' Perceptions of Their Teachers*. Ph.D. Edu., Agra University.

Silins, H., & Mulford, B. (2002). Schools as Learning Organizations: The Case for System, Teacher and Student Learning. *Journal of Educational Administration*, 40(5), 425- 446.



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DYNAMIC LINKAGES BETWEEN PSYCHOLOGICAL CONTRACT BREACH AND EMPLOYEES' WORKPLACE BEHAVIORS IN POWER SECTOR OF PAKISTAN

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ABSTRACT

This study examined the link between psychological contract breach and employees' workplace behavior by testing the moderating role of workplace spirituality. Behavioral facets of the workplace include voice, neglect, counterproductive work behavior and OCB which were taken as dependent variables. This study adopts a survey research design. The data was mustered over a self-administered questionnaire from a sample of employees randomly selected from a population of power sector employees of Pakistan. The study has empirically established that psychological contract breach has a positive impact on employee negative workplace behaviors and it has a significant negative impact on positive workplace behaviors. Results reveal a negative significant effect on positive behaviors citizenship and voice. The role of workplace spirituality was studied as a moderator between breach and workplace behavior. In this perspective, workplace spirituality is an important and influential aspect that cannot be ignored in the human resource management context and particularly in the organizational psychology field.

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1. INTRODUCTION

The psychological contract has been considered as an individual perception of shared obligations in exchange relationships. The psychological contract is the leading and most critical aspect of organizational psychology (Robinson & Morrison, 1995). Among the consequences of "psychological contract breach", the most common ones include; lack of ownership, increase in wastage, high cost, poor performance and low productivity (Chao et al., 2011). Looking at these outcomes as possible effects of different relationships between different variables, researchers have

been looking at them in various organizational settings to see as to what extent Psychological Contract Breach (PCB) affects employee behavior in their respective organizations. The psychological contract has been studied with various perspectives including both, the organization as well as employee perspectives. It is a composite construction that consists of many dimensions, one of which is a cognitive organizational obstruction that has been studied in relationship with neglect, voice, and turnover intention (Gibney, 2007).

Bolon, (1997), Robinson & Morrison (1995), Rousseau (1990) have investigated the adverse impact of psychological contract breach on employees' attitude, behavior and performance. Empirical studies have looked into the relationship of PCB with counter-productive work behavior of employees with both the organizational and supervisor perspective (Griep & Vantilborgh, 2018). From these and other similar studies, it can easily be decided that psychological contract is one of the most powerful constructs linked with employee's workplace behavior and performance. It is necessary to investigate and thoroughly understand PCB and its detrimental impact on employee workplace behavior. Psychological contract breach is linked with behavior that, in turn, is linked with employee performance as well as organizational performance and productivity. Organizations need to be aware of the causes and consequences of psychological contract breach and its corresponding effects on the human resource management system. If it is ignored, organizations are supposed to suffer in terms of effectiveness, productivity, profitability, and performance.

Spirituality is a universal human trait and experience that touches us all. It is a deep sense of aliveness and interconnectedness within our being. It is something that is bigger than we are and helps us in searching for meaning in our life. It intricately links an individual's internal life with the external world. Having said that, one cannot ignore its role in upsetting the connection between employee workplace behavior and psychological contract breach. Therefore, this research is intended to investigate PCB in relation to worker behavior with the moderation of workplace spirituality. Employee behavior, in the context of this research, refers to voice, neglect, counter-productive workplace behavior (CWB) and organizational citizenship behavior (OCB). Past studies have investigated other related constructs of the psychological contracts with various dimensions of employee behavior. This research is supposed to investigate the relationship of PCB with neglect, voice, CWB, and OCB with the moderation of workplace spirituality, as an effort to address the existing research gap.

The breach or fulfillment of psychological agreement affects employees' overt and covert behavior (Morrison & Robinson, 1997). Therefore, an organization where employees experience PCB is believed to suffer seriously in terms of performance and productivity. The organization has to sustain huge losses if its employees are in a state of a high level of psychological contract breach. It has been noted that PCB negatively affects the positive behavior facets and positively affects the negative workplace behaviors. It is a double-edged sword. Organizations, where employees experience a high level of PCB, suffer both in terms of reduced favorable behaviors and increased unfavorable behaviors. PCB is a schema that develops over time through interactions and experiences of employees at the workplace and it determines the strength, level, and direction of the relationship between employee and employer (Lodha & Pathak, 2017). Because of the reasons and

consequences of PCB and its impact on the organizational environment, worker relations and performance, the study and investigation of PCB are highly beneficial for organizational performance and management effectiveness.

2. LITERATURE REVIEW

This research looks at the connection of PCB (psychological contract breach) and employee workplace behavior with the moderation of workplace spirituality. The behavior facets which put under the scope of this study are neglect behavior, voice behavior, counter-productive work behavior (CWB) and organizational citizenship behavior (OCB). The PCB is assumed to have a positive impact on neglect and counter-productive work behaviors, whereas, it has a negative impact on voice behavior and “organizational citizenship behavior”. Workplace spirituality has been investigated as a moderating variable in connection amid workplace behaviors and PCB employees. The variables of the study had eight hypothetical relationships, hence constituting eight hypotheses. Four hypotheses are regarding the impact of PCB on employee behavior facets and another four hypotheses are regarding the moderation of workplace spirituality. Investigating moderation of workplace spirituality between PCB and the workplace behaviors is the major contribution of this study towards the theory of psychological contract and the field of organizational psychology.

Researchers have empirically evidenced that employees contribute to the best of their abilities with high performance and try to play extra-role behavior when they perceive they are fairly treated. On the contrary, they limit their efforts to the minimum job requirements when they perceive that they are not adequately treated by the organization (Rhoades & Eisenberger, 2002). It is evident that “an employee’s perception” of support from the organization and its agents results in employees’ extra-role behavior (Wayne et al., 1997). A psychological contract is a determinant of employees’ behavior; balanced psychological contract is reciprocated by employees with positive behavior and good performance. Employees demonstrate the expected behaviors and remain satisfied with their jobs. Researchers have found that psychological contract violation harms OCB, consequently an employee, sometimes, considers options to part ways with their employer either emotionally by disassociating themselves or by quitting the organization (Gibney et al., 2011).

When an “employee perceives that the organization” is not fulfilling the implicit terms of the psychological contract, they start thinking over their exchange relationship with the organization. Such feelings harm the exchange relationship. The research study revealed that, in a situation where employees feel psychological contract breach, they may quit, propose recommendations, remain loyal and/or start a neglecting behavior (Rusbult et al., 1988). (Krivokapic et al. (2009) have argued that avoiding PCB and upholding psychological contract through proper understanding, can enhance the workers’ motivation, morale, and commitment. Understanding of PCB provides remedial measures like developing communication channels to maintain clarity and minimize misunderstanding which helps to overcome the problems due to misperceptions (Brown, 2015). Numerous studies have addressed various dimensions of PCB and its related constructs. However,

Ahmad et al. (2018), Parzefall & Shapiro (2011), Sahin & Cankir (2018) have expressed their concern that the existing body of knowledge regarding PCB is not exhaustive in terms of covering all the aspects that affect organizations and we need to know a lot about this field of inquiry.

Keeping this wanting aspect, it has been noted that the moderating role of workplace spirituality between PCB and employee's workplace behavior has not been addressed so far. Therefore, there is a need for addressing this gap so that the concept could be understood with more wholesomeness and thereby make substantial support to the body of knowledge and industry in this field of study. Given the above discourse, eight hypotheses regarding the linkages between workplace behavior and PCB and the moderation of the workplace spirituality have been drawn. The relationship between PCB and four workplace behavior facets constitutes four hypotheses of the direct impact of PCB on the dependent variables. Another four hypotheses show moderation of workplace spirituality between PCB and the same workplace behavior facets. These hypotheses are:

- H1:** PCB has a significant negative impact on voice behavior.
- H1a:** Workplace "spirituality moderates the link" of PCB and voice.
- H2:** PCB has a significant negative impact on neglect behavior
- H2a:** Workplace "spirituality moderates the association" of PCB and neglect behavior.
- H3:** PCB has a significant positive impact on CWB
- H3a:** Workplace "spirituality moderates the link" of PCB and CWB.
- H4:** PCB has a significant negative impact on OCB
- H4a:** Workplace spirituality moderates the connection between PCB and OCB.

2.1 CONCEPTUAL FRAMEWORK

This study examined the relationship of PCB with employee workplace behavior with the moderation of workplace spirituality. The relationship of PCB has conceptually been linked with voice, neglect, counter-productive work behavior and organizational citizenship behavior with the moderation of workplace spirituality. Employees are in a relational-transactional contract with employers. The transactional contract refers to reciprocation with monetary and short term returns and relational contract refers to the long term relationship with the organization (Rousseau, 2000). This study has investigated that Psychological contract breach affects this relationship. The conceptual diagram was shown in Figure 1. The relationship amid PCB (independent variable) and workplace behavior (dependent variable) faceted as voice, neglect, organizational citizenship behavior and counterproductive work behavior has been moderated by workplace spirituality.



Figure 1: Psychological Contract Breach, Employees' Work Behaviors and Workplace Spirituality.

3. METHOD

3.1 POPULATION AND SAMPLING

The population of the study is the junior and mid-level managers of the power distribution sector of Pakistan, serving in the power distribution companies of PEPCO. The total strength (population) of the mentioned category of employees is 3368 (MoE, 2018). The junior and mid-level managers serve as line managers of the organization. Therefore, this segment of the population was deemed most appropriate for the study of psychological contract breach. The reason being they are directly influenced by the policies and decisions passed by the top-level managers and they directly lead the employees responsible for execution (Lopez-Cotarelo, 2011). The research employed a simple random sampling technique because the population was known, although it was spread in the electricity companies all over Pakistan. The sample size was 350 worked out as per Krejcie and Morgan (1970) at a 95 percent confidence level.

3.2 DATA COLLECTION

Over the self-reported questionnaire, data were mustered by visiting respondents personally, and through courier and email, in case the respondents were in far-flung areas, for 10 months during late 2018-2019. The questionnaire for PCB, consisting of nine items, was adopted from Robinson and Morrison (2000). Six items scale for the voice from Van Dyne and LePine (1998) has been employed. For the neglect construct, four items scale from Kidwell and Robie (2003) has been employed. For CWB, the ten items scale of Spector et al. (2010) has been employed. For measuring OCB, the 15 items scale developed by Podsakoff et al. (1990) as cited and used by Agentero, Cortese, and Ferretti (2008) has been employed. While for determining the construct of spirituality, nine items scale established by Petchsawanga and Duchon (2009) has been used in this research.

3.3 DATA ANALYSIS

The data analysis was done through SPSS. In this regard, factor analysis was showed to determine the construct instrument validity. A correlation test was applied to define the association between PCB and employee workplace behaviors. Regression tests were done to decide the variance explained by the independent variable in each dependent variable. The regression model of was used to test the moderation of workplace spirituality. Referring to the analysis of moderation, the interaction effect of PCB and workplace spirituality was determined to find whether or not such effect is significant in predicting the employee workplace behavior. The Hayes (2013) process model-1 for SPSS serves the purpose of this study, the mentioned software plug-in for SPSS was used to analyze the data for the moderation of workplace spirituality.

4. RESULTS OF STUDY

Before testing of hypotheses, the data was examined for its linearity, homoscedasticity, normality, multi-collinearity, reliability, and validity. The effects revealed that all of the data were free from any issues associated with normality, reliability, and validity, etc. The results for testing hypotheses are given.

The outputs Hypothesis H1 are provided in Table 1, consisting of the model summary statistics of the regression test. The output shows the impact of psychological contract breach on voice. R statistics (0.34) is the correlation coefficient which exhibits that there is a 34 % correlation between PCB and voice. The R square value (0.12) means that PCB explains 12% variance in the voice. The relationship between PCB and voice is significant as the p-value (<0.001) is below 0.05. Thus, psychological contract breach (PCB) is a significant predictor of voice behavior. As a conclusion, empirical data support the hypothesis.

Table 1: Model Summary Statistics: H1 (PCB and Voice).

R	R Sq.	SME	F	Df1	Df2	P
0.34	0.12	0.33	12.02	3	276	<0.001

The second hypothesis H1a results Table 2 show the interaction effect, that is, Int_1. The p-value (0.015) is significant. In addition to that, there is no zero in-between the lower level conditional interaction (LLCI) and upper-level conditional interaction (ULCI), which in the instant case varies between -0.2589 and -0.0277 having no zero in between. These results show that the conditional interaction effect of workplace spirituality as a moderating variable between the PCB and voice behavior is significant.

Table 2: Statistics for Moderation (H1a)

Model	Coeff	SE	T	P	LLCI	ULCI
Constant	0.62	0.43	1.43	0.151	-0.22	1.46
PCB	0.26	0.12	2.02	0.043	0.01	0.51
WS	0.77	0.19	4.03	0.000	0.39	1.14
Int_1	-0.14	0.05	-2.43	0.015	-0.2589	-0.0277

The third hypothesis H2 results Table 3 consist of the regression test model summary statistics for PCB and voice. It determines the impact of psychological contract breach on neglect behavior. The R statistics (0.37) is the correlation coefficient. The given value of R means that there is a 37 % correlation between PCB and neglect. The R square value (0.14) means that PCB explains 14% variance in neglect. The relationship between PCB and neglect as criterion and outcome variables is significant as the p-value (0.000) is significant. Therefore, psychological contract breach is a significant predictor of voice behavior.

Table 3: Model Summary Statistics: H2 (PCB & NB)

R	R Sq.	SME	F	Df1	Df2	p
0.37	0.14	0.54	14.46	3	276	0.000

The fourth hypothesis H2a results Table 4 carry the empirical findings for the moderation of the workplace spirituality between the independent variable PCB and dependent variable neglect behavior. Moderating impact is shown by the interaction effect that is, Int_1. The significant p-value (0.015) and that there is no zero between the lower level conditional interaction (LLCI) and upper-level conditional interaction (ULCI) which varies between -0.29 and 0.00 having no zero in

between. These statistics show that the conditional interaction effect of workplace spirituality as a moderating variable between the PCB and neglect behavior is significant.

Table 4: Statistics for Moderation (H2a)

	Coeff	SE	T	P	LLCI	ULCI
Constant	1.94	0.55	3.52	0.151	0.86	3.027
PCB	0.57	0.16	3.48	0.043	0.25	0.89
WS	0.42	0.24	1.74	0.000	-0.05	0.90
Int_1	-0.14	0.07	-1.90	0.015	-0.29	0.00

The fifth hypothesis H3 results Table 5 carry the empirical findings of the regression model summary statistics which show the impact of psychological contract breach as an independent variable on the dependent variable counter-productive work behavior (CWB). The R statistics (0.47) is the correlation coefficient which shows there is a 47 % correlation between PCB and counter-productive work behavior. The R square value (0.21) means that PCB explains a 21% variance in CWB. The relationship between PCB and CWB as criterion and outcome variables is significant as the p-value (<0.001) is below 0.05. Therefore, psychological contract breach is a significant predictor of counter-productive work behavior. The empirical data again support the hypothesis of the study.

Table 5: Model Summary Statistics: H3 (PCB & CWB)

R	RSq	SME	F	Df1	Df2	P
0.47	0.21	0.58	25.49	3	276	<0.001

The sixth hypothesis H3a examined that workplace spirituality moderates the connection amid PCB and counter-productive work behavior. Table 6 shows the regression statistics for the moderation of the workplace spirituality between PCB and counter-productive work behavior. Moderating impact is shown by the interaction effect that is, Int_1. The significant p-value (0.015) and that there is no zero between the lower level conditional interaction (LLCI) and upper-level conditional interaction (ULCI), which in the instant case varies between -0.36 and 0.00 having no zero in-between, is the evidence of significance.

Table 6: Statistics for Moderation (H3a)

	Coeff	SE	T	P	LLCI	ULCI
Constant	1.50	0.57	2.64	0.008	0.38	3.63
PCB	0.79	0.17	4.67	0.000	0.46	1.13
WS	0.48	0.25	1.91	0.056	-0.01	0.98
Int_1	-0.21	0.07	-2.74	0.006	-0.36	0.00

The seventh hypothesis H4 states that psychological contract breach has a significant negative effect on OCB. Table 7 is the regression model summary statistics which shows the impact of psychological contract breach on organizational citizenship behavior. The R statistic (0.45) is the correlation coefficient which means there is a 45 % correlation between PCB and OCB. The R square value (0.21) means that PCB explains a 21% variance in organizational citizenship behavior. The relationship between PCB and OCB as criterion and outcome variables is significant as the p-value (<0.001) is below 0.05. Therefore, psychological contract breach is a significant predictor of organizational citizenship behavior. The empirical data support this hypothesis as well.

Table 7 Model Summary Statistics: H4(PCB and OCB)

R	RSq.	SME	F	Df1	Df2	P
0.45	0.21	0.63	22.82	3	276	<0.001

The eighth hypothesis H4a results Table 8 shows regression test statistics for the moderation of the workplace spirituality between the independent variable PCB and dependent variable organizational citizenship behavior. The moderation impact in the table is shown by the interaction effect that is, Int_1. The significant p-value (0.007) and there is no zero between the lower level conditional interaction (LLCI) and upper-level conditional interaction (ULCI) which in the instant case varies between -0.37 and -0.05 having no zero in between. These statistics show that the conditional interaction effect of workplace spirituality as a moderating variable between the PCB and organizational citizenship behavior is significant.

Table 8: Statistics for Moderation (H4a)

	Coeff	SE	T	P	LLCI	ULCI
Constant	1.60	0.59	2.71	0.007	0.43	2.76
PCB	0.78	0.17	4.47	0.000	0.44	1.13
WS	0.47	0.26	1.81	0.071	-0.04	0.98
Int_1	-0.21	0.08	-2.68	0.007	-0.37	-0.05

5. DISCUSSION

By thorough analysis of the empirical effects of the present study, it is evident that these results are in line with earlier studies conducted in various cultures of the world. For instance, the studies conducted in the USA (Thomas et al., 2014) and Chinese international corporations in the western countries (Guo, 2017) have yielded similar findings, which are consistent with the finding of this study. Similarly, a study conducted in Turkish organizations (Karatepe & Kaya, 2020) and another such study conducted the South African industry (Penfold & Ronnie, 2015) also found that PCB has a significant relationship with voice behavior. However, these finding differs with studies conducted in Chinese culture, which found that PCB has no significant relationship with voice behavior (Shan, 2012; Shi-bin & Yong, 2014). As a whole, the empirical outcomes of the study support the hypothesis. It is, thus, concluded that psychological breach contract has a significant undesirable impact on constructive voice behavior.

The findings are also consistent with studies led in western countries and studies led in the Asian culture (Ahmed et al., 2016), another study conducted in Chinese culture (Shen et al., 2019). Researchers found in larger studies consisting of 41 samples from various cultural origins like American, French, Italian, South East Asian, Spanish and English that PCB is significantly positively related to workplace neglect behavior (Cantisano et al., 2008). However, these results are inconsistent with another study conducted in China by researchers (Shan, 2012; Shi-bin & Yong, 2014). Similarly, researchers (Skarlicki & Folger, 1997) believe that employees exhibit such behaviors as retaliation when they experience and come across unfair treatment in their workplace from the employer directly or indirectly. A psychological contract breach is a construct that triggers negative feelings among its beholders. Since PCB and CWB are both negative and detrimental constructs, the two variables were, therefore, posited to have a positive relationship.

PCB was presumed to have a positive impact on CWB. In other words, H3 assumed that the greater the level of PCB the greater will be the CWB level in an organization and vice versa. Similarly, researchers (Kaul & Kaul, 2017) in their study conducted in India, that is, south Asian

culture found that PCB has a significant impact on CWB. Researchers (Onyishi & Onunkwo, 2014) in a study conducted in Nigerian organizations have found empirical evidence regarding the relationship between PCB and CWB which too, is in line with the results of this study. In addition to the aforementioned studies researchers (Galic et al., 2016) in a study conducted in Croatia have also found that PCB has a significant positive relationship with CWB. Considering the aforesaid cited studies led in various cultures and the empirical findings of this study, it is decided that PCB has a significant positive effect on CWB.

Finally, this study empirical results show that the connection amid the mentioned two variables is highly significant and the results of are in line with the study conducted on manufacturing plants' employees in Europe by Abela & Debono (2019) and research conducted on employees of various cultural origins like American, French, Italian, South East Asiatic, Spanish and English found that PCB is significantly negatively related with OCB (Cantisano, et al., 2008). Similarly, a study conducted on Croatian employees has also yielded similar empirical results (Galic, et al., 2016).

6. CONCLUSION

The study and investigation of psychological contracts are extremely important. PCB has serious detrimental repercussions for the organization where employees recognize that their contract has been ruptured. The consequences of psychological contract breach are highly damaging to organizational performance. Employee's workplace behavior is significantly influenced by the feeling of a breach. The study determines that psychological contract breach positively impacts the negative workplace behaviors like neglect and counterproductive work behavior. Whereas, this construct negatively impacts the workplace behaviors of employees. As such, the psychological contract was found to has a significant negative effect on OCB and voice behaviors. This research has theoretically contributed to the field of organizational behavior by introducing the moderation role of workplace spirituality between PCB and workplace behavior as a new dimension of psychological contract theory. Workplace spirituality has been shown to significantly moderate the link amid PCB and employee workplace behaviors. The negative impact of PCB on OCB and voice turns less significant in the magnitude of negativity. Whereas the positive impact of PCB on neglect and counterproductive also turns less significant and the change is attributed to workplace spirituality which moderates this connection between workplace behavior and PCB.

7. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding authors

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9. REFERENCES

- Abela, F., & Debono, M. (2019). The relationship between psychological contract breach and job-related attitudes within a manufacturing plant. *Sage Journal*, 9(1), 1-10.
- Agentero, P., Cortese, C., & Ferretti, M. S. (2008). An evaluation of organizational citizenship behavior: Psychometric characteristics of the Italian version of Podsakoff et al.'s scale. *TPM*, 15(2), 61-75.

- Ahmad, M. I., Firman, K., Smith, H., & Smith, A. P. (2018). Psychological contract fulfillment and well-being. *Advances in Social Sciences Research Journal*, 5(12), 90-101.
- Ahmed, E., D'Netto, B., Chelliah, J., & Fein, E. (2016). Psychological contract breach: Consequences of unkept promise of permanent employment. *Contemporary Management Research*, 12(2), 183-212.
- Bolon, D. S. (1997). Organizational citizenship behavior among hospital employees: A multidimensional analysis involving job satisfaction and organizational commitment. *Hospital and Health Services Administration*, 42(2), 221-241.
- Brown, L. A. (2015). *Communication and Psychological Contracts: The International Encyclopedia of Interpersonal Communication* (Vol. 3). California: John Wiley and Sons.
- Cantisano, G. T., Dominguez, J. F. M., & Depolo, M. (2008). Psychological contract breach and outcomes: Combining meta-analysis and structural equation models. *Psicothema*, 20(3), 487-496.
- Chao, J. M. C., Cheung, F. Y. L., & Wu, A. M. S. (2011). Psychological contract breach and counterproductive workplace behaviors: Testing moderation effect of attribution style and power distance. *The International Journal of Human Resource Management*, 22(4), 763-777.
- Galic, Z., Grabovac, M. T., Gotvald, I., & Jerneic, Z. (2016). When employers betray: A study of psychological contract breach among Croatian employees. *Zagreb International Review of Economics & Business*, 19, 59-69.
- Gibney, R. (2007). *Cognitive Organizational Obstruction; Its Nature, Antecedents, and Consequences*. PhD Dissertation, University of Pittsburgh.
- Gibney, R., Zagenczyk, T. J., Fuller, J. B., & Hister, K. (2011). Exploring organizational obstruction and the expanding model of organizational identification. *Journal of Applied Psychology*, 41(5), 1083-1109.
- Griep, Y., & Vantilborgh, T. (2018). Let's get cynical about this! Recursive relationships between psychological contract breach and counterproductive work behavior. *Journal of Occupational and Organizational Psychology*, 91(2), 421-429.
- Guo, Y. (2017). Effect of psychological contract breach on employee voice behavior: Evidence from China. *Social Behavior and Personality: An International Journal*, 45(6), 1019-1028.
- Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis* (1st ed. Vol. 1). New York: Guilford Publication, Inc.
- Karatepe, O. M., & Kaya, B. (2020). Attitudinal and behavioral outcomes of work-life balance among hotel employees: The mediating role of psychological contract breach. *Journal of Hospitality and Tourism Management*, 42, 199-209.
- Kaul, N., & Kaul, P. (2017). The effect of social influence on psychological contract breach evaluation: how it is related to deviant workplace behavior. *Indira Management Review*, 11(1), 38-49.
- Kidwell, R. E., & Robie, C. (2003). Withholding effort in organizations: Toward development and validation of a measure. *Journal of Business and Psychology*, 17(4), 537-561.
- Krejcie, R. V., & Morgon, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30, 607-610.
- Krivokapic-Skoko, B., O'Neil, G., & Dowell, D. (2009). Assessing the contents of the psychological contract: A cross-sectional survey of the academics at an Australian University. *New Zealand Journal of Employment Relations*, 34(2), 4-28.

- Lodha, D., & Pathak, K. (2017). Effect of psychological contract on employee engagement. *Rising- A Journal of Researchers*, 1(1), 5-14.
- Lopez-Cotarelo, J. (2011). *HR discretion: Understanding line managers' role in human resource management*. Paper presented at the Annual Meeting, Academy of Management.
- MoE. (2018). Year Book 2016-17 of the Federal Ministry of Energy (Power Division) Government of Pakistan.
- Morrison, E. W., & Robinson, S. L. (1997). When employees feel betrayed: A model of how psychological contract violation, develops. *Academy of Management Review*, 22(1), 226-256.
- Onyishi, I. E., & Onunkwo, C. B. (2014). Counterproductive work behavior among school teachers: The contributions of psychological contract breach and job stress. *Journal of the African Educational Research Network*, 14(2), 140-147.
- Parzefall, R. M., & Coyle-Shapiro, J. (2011). Making sense of psychological contract breach. *Journal of Managerial Psychology*, 26(1), 12-27.
- Penfold, R., & Ronnie, L. (2015). Peer-to-peer psychological contracts in the South African wine industry. *SA Journal of Human Resource Management*, 13(1), 701-710.
- Petchsawanga, P., & Duchon, D. (2009). Measuring workplace spirituality in an Asian context. *Human Resource Development International*, 12(4), 459-468.
- Rhoades, L., & Eisenberger, R. (2002). Perceived organizational support: A review of the literature. *Journal of Applied Psychology*, 87(4), 698-714.
- Robinson, S. L., & Morrison, E. W. (1995). Psychological contracts and OCB: The effect of unfulfilled obligations on civic virtue behavior. *Journal of Organizational Behavior*, 16(3), 289-298.
- Robinson, S. L., & Morrison, E. W. (2000). The development of psychological contract breach and violation: A longitudinal study. *Journal of Organizational Behavior*, 21, 525-546.
- Rousseau, D. M. (1990). New hires' perceptions of their own and their employer's obligations: A study of psychological contracts. *Journal of Organizational Behavior*, 11(5), 389-400.
- Rousseau, D. M. (2000). Psychological contract inventory technical report. Retrieved on March 2017, www.andrew.cmu.edu/user/rousseau/0_reports/PCI.pdf
- Rusbult, C. E., Farrell, D., Rogers, G., & Mainous, A. G. (1988). Impact of exchange variables on exit, voice, loyalty and neglect: An integrative model of responses to declining job satisfaction. *The Academy of Management Journal*, 31(3), 599-627.
- Sahin, S., & Cankir, B. (2018). Psychological well-being and job performance: The mediating role of work engagement. *Hitit University Journal of Social Sciences Institute*, 11(3), 2549-2560.
- Shan, B. (2012). *The role of psychological contract breach in determining Chinese civil servants' behavioral responses to organizational change*. PhD, John Moores University, Liverpool, UK.
- Shen, Y., Schaubroeck, J. M., Zhao, L., & Wu, L. (2019). Work group climate and behavioral responses to psychological contract breach. *Frontiers in Psychology*. DOI: 10.3389/fpsyg.2019.00067
- Shi-bin, Z., & Yong, Z. (2014). Influence of psychological contract breach on oversea employees' behavior in Chinese transnational corporations. *Journal of Chemical and Pharmaceutical Research*, 6(7), 554-561.
- Skarlicki, D. P., & Folger, R. (1997). Retaliation in the workplace: The role of distributive, procedural and interactional justice. *Journal of Applied Psychology*, 82(3), 434-443.

- Spector, P. E., Bauer, J. A., & Fox, S. (2010). Measurement artifacts in the assessment of counterproductive work behavior and organizational citizenship behavior: Do we know what we think we know? *Journal of Applied Psychology*, 95(4), 781-790.
- Thomas, H. W., Feldman, D. C., & Butts, M. M. (2014). Psychological contract breaches and employee voice behaviour: The moderating effects of changes in social relationships. *European Journal of Work and Organizational Psychology*, 23(4), 537-553.
- Van Dyne, L., & LePine, J. A. (1998). Helping and voice extra-role behaviors: Evidence of construct and predictive validity. *Academy of Management Journal*, 41(1), 108-119.
- Wayne, S. J., Shore, L. M., & Liden, R. C. (1997). Perceived organizational support and leader-member exchange: A social exchange perspective. *Academy of Management Journal*, 40(1), 82-111.
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A METHOD FOR DETERMINING THE THERMOPHYSICAL PROPERTIES OF A CONSTRUCTION OBJECT

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ABSTRACT

Based on the analysis of the literature, a method was proposed for determining the actual thermophysical properties (thermal conductivity) of an object, according to which a portable automated installation was later developed to determine the thermophysical properties of an object using non-destructive testing using modern means of control and information processing for more a short period of time, non-stationary method. The developed installation is capable of determining the thermophysical properties of an object, as well as the spatial pattern of the distribution of heat flows inside the object, using non-destructive testing.

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1. INTRODUCTION

Thermophysical properties (TPP) determine the discharge of fuel, electricity and materials temperature distributions. The analysis of the existing methods of determining the TPP of the object under study has shown that it is possible to develop an installation that will determine the TPP of the object NDTM using modern means of information handling and processing in a shorter period of time - in a non-stationary way (Ametistov, 2000; Bogoslovsky, 2013; Vavilov, 2009; Vidin et al., 2018; Fokin & Chernyshov, 2004; Kudinov, 2015; Fokin & Kovylin, 2009; Barilovich & Smirnov, 2014; Kabanov et al., 2014; Thermal protection of buildings, 2012). It should be noted that the non-stationary methods of TPP detection are the most promising due to their simplicity and short research time. According to the analysis performed, an algorithm (Malyavina, 2007; Kabanov & Panfilov, 2017) and an installation (Kabanov et al., 2017) were developed for the energy-efficient study of TPP of an NDTM object (Kabanov & Panfilov, 2017; Panfilov & Kabanov, 2016; Kabanov et al., 2016; Panfilov et al., 2019).

This study is devoted to the experimental studies of Thermo Physical Properties (TPP) of objects. The existing methods of TPP determination are analyzed. They presented the algorithm developed by the researcher for the TPP determination of the object under study. They described the operation of the unit for TPP (heat transfer coefficient, heat transfer resistance and specific thermal characteristic) determination of the object under study. The formulas are given required for TPP calculation. The experimental results of the study are presented. The main advantages of the developed unit are described.

An installation block diagram is shown in Figure 1. The algorithm for assessing the thermal properties of the object is shown in Figure 2.

Figure 1: Block diagram of the designed portable unit.

observed, the following condition is checked: " $T_{\text{inside}} < T_{\text{inside the specified}}$, the current temperature inside the object is higher than the set maintenance temperature", if the condition in 9 is observed, the heat supply is stopped, the ambient temperature reading outside the object under research is recorded in the device memory in 10, and then in 11, a stop is made for a pause in time of the calculation of the installation operation in the active mode for the set maintenance time. The condition is checked in 12: " $t_1 > t_2$, research time is exceeded or equal to the set research time", if it is performed, then in 13 the condition is checked: " $T_{\text{inside}} < T_{\text{inside the specified}}$, the current temperature inside the object is less than the set maintenance temperature" when it is performed - return to 4, if it is not performed in 9, when the conditions in one of the blocks 7 or 12 are reached, the algorithm passes to block 14, where the calculation of the installation time is stopped in the active mode. The ambient temperature reading is recorded in 15 outside the tested object to the device memory, in 16 the required values are calculated, and in 17 data output.

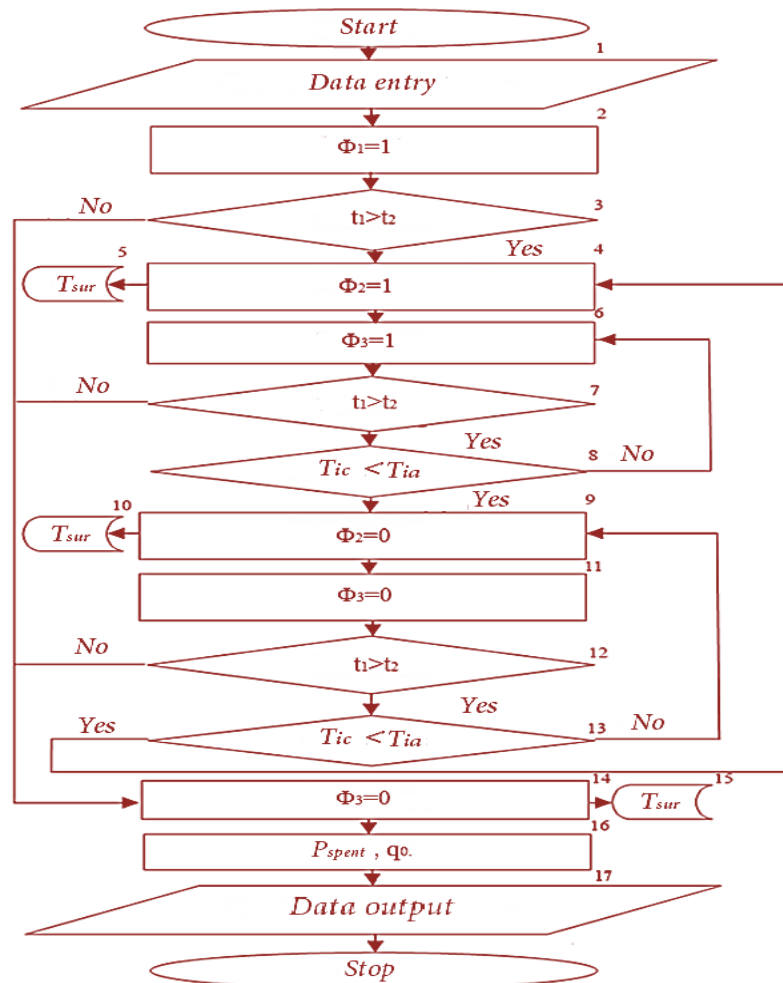


Figure 2: Block diagram of the algorithm for determining the TPP object

3. MATHEMATICAL MODELING

The needed mathematical formulas to determine the required values for the experiment are given below.

Average ambient temperature during the survey:

$$\overline{T}_{\text{surrounding}} = \frac{\sum T_{\text{surrounding}i}}{n} \quad (1),$$

where $T_{\text{surrounding}i}$ is the ambient temperature at the “i” moment of the study.

n - quantitative $T_{\text{surrounding}}$ readings during the study.

Average P_{spent} power consumption to maintain the set temperature during the survey (W):

$$P_{\text{spent}} = P_{\text{source}} \cdot \frac{t_{\text{work}}}{t_{\text{maintenance}}} \quad (2)$$

where P_{source} - rated power of a heat supply source, t_{work} - time of active operation of a heat supply source, $t_{\text{maintenance}}$ - set time of maintenance of the set temperature T_B .

The ratio [28] is available from references:

$$q_0 V (T_{\text{inside}} - T_{\text{surrounding}}) = P_{\text{spent}} \quad (3)$$

where q_0 is the specific thermal characteristic of the object $W/(m^3 \cdot ^\circ C)$;

Specific thermal characteristics of the object:

$$q_0 = \frac{P_{\text{spent}}}{V \cdot (T_{\text{inside}} - \bar{T}_{\text{surrounding}})} \quad (4).$$

To determine the required capacity of the heat supply system to maintain the optimal temperature inside the facility, considering the coldest five-day period:

$$P_{\text{source}} = q_0 V (T_{\text{within nominal}} - T_{\text{average ambient}}) \quad (5),$$

where T_{Bn} - is the optimal air temperature inside, according to the normative papers for this type of facilities; $T_{\text{Окрн}}$ - is the average ambient temperature, considering the coldest five-day period for this location, as determined by the normative documents; P_{ucm} is the power of the heat supply source to maintain the optimal temperature inside the facility.

4. RESULT AND DISCUSSION

Based on the analysis of the literature presented in this article, a method was proposed for determining the actual thermophysical properties of an object, according to which a portable automated installation was later developed to determine the thermophysical properties of an object using non-destructive testing using modern means of control and information processing for more a short period of time - non-stationary way. The installation on the basis of the carried-out analysis and theoretical data to determine the TPP of the object under study. Figure 3 represents a block diagram of the installation.

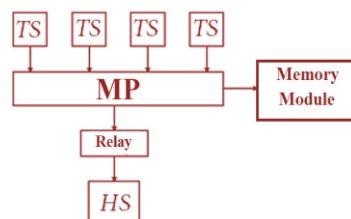


Figure 3: Block diagram of mobile installation for TPP detection.

Figure 4 provides a schematic diagram of the mobile automatic installation running on the Arduino Mega 2560 microcontroller. It should be noted that the Arduino MEGA 2560 is designed for projects that require more I/O lines, more sketch memory and more RAM.

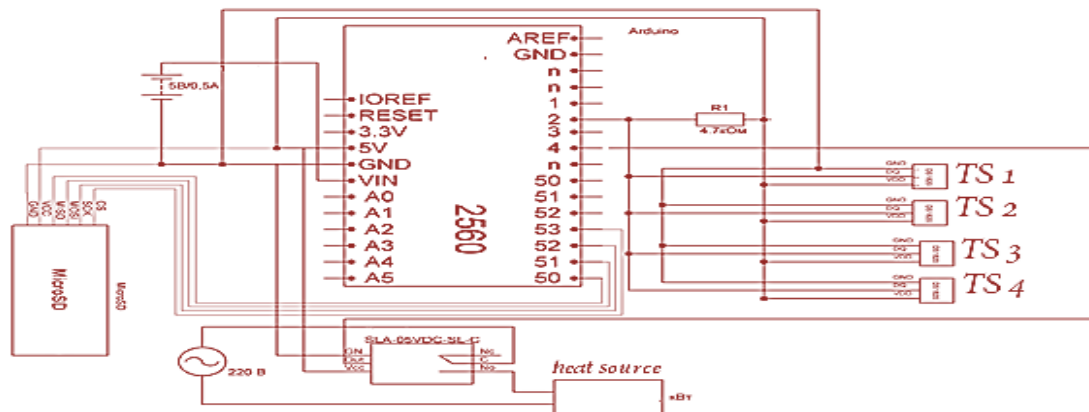


Figure 4. Schematic diagram of the portable automated installation to determine the FPS of the object

The code for the mobile automated system control program is written in the C++ programming language (Kabanov et al., 2018). We also used the complex assembled on the programmable relay PR200. The schematic diagram of the portable automated installation working on the programmable relay PR200 is provided in Figure 5.

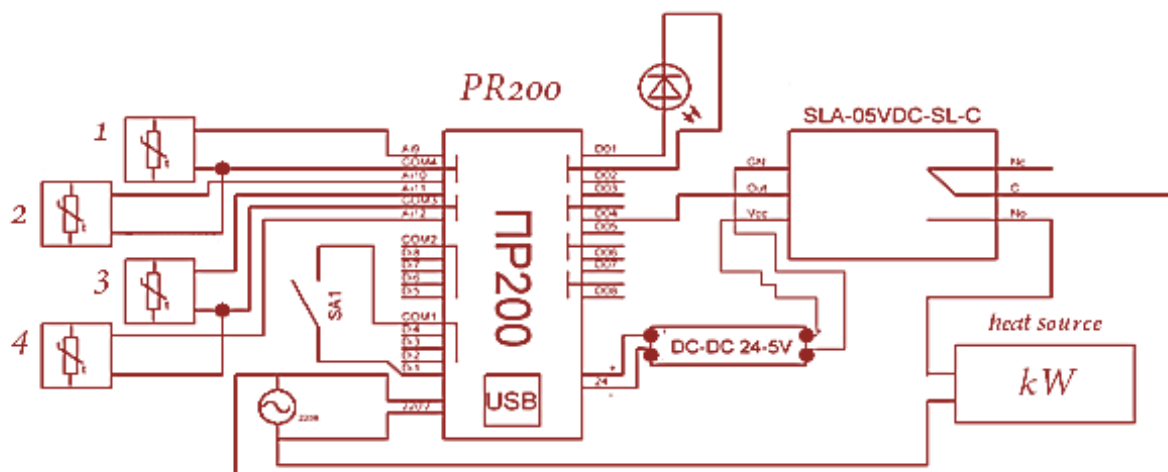


Figure 5: Schematic circuit diagram of mobile automated installation on programmable relay PR200.

The control program code developed in the Owen Logic programming environment to be used for controlling the mobile automated installation with the PR200 programmable relay (Panfilov et al., 2016) is provided in Figure 6.

It works in the following way: setting the necessary values - the time of examination, temperature maintaining period inside the examined object. After entering the necessary data the installation set in the running mode compares the obtained temperature readings inside the object, then checks the required condition to fulfill the task, once all the conditions are reached, the installation completes the process, and according to the resulting data we estimate the TPP of the object of study. The designed model of the automated mobile installation to define the valid FPS of the construction object is provided in Figure 7.

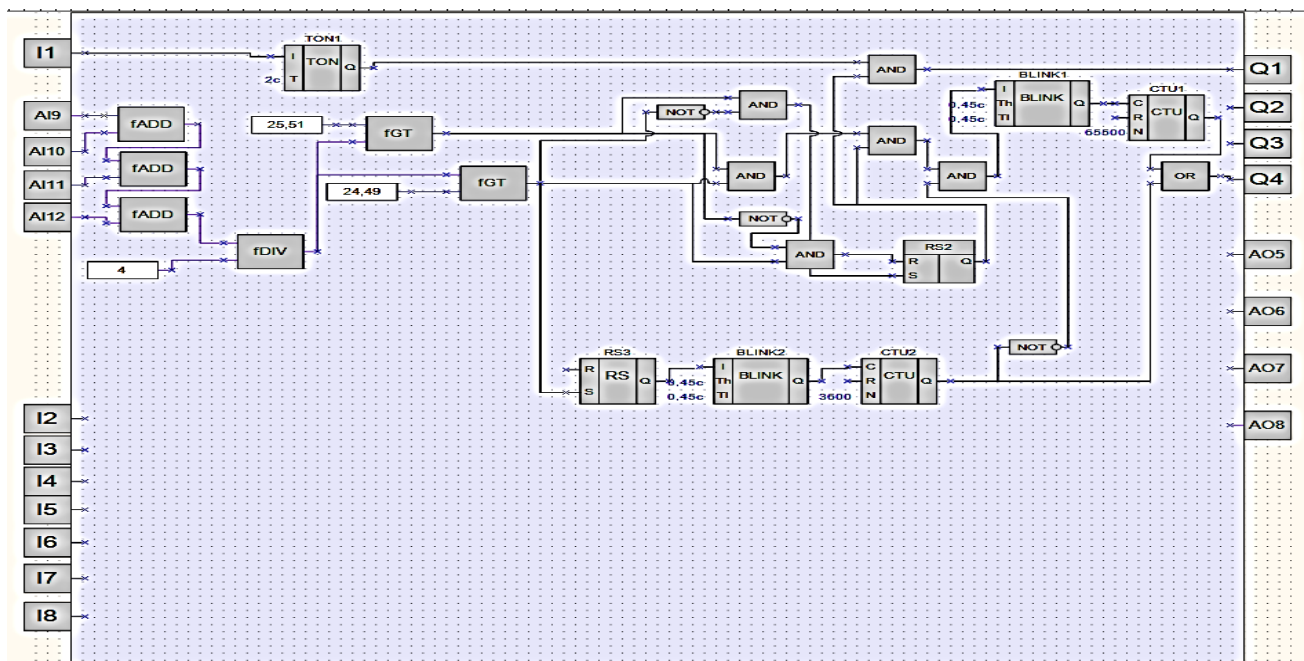


Figure 6: The program for implementing actions algorithm to control automated mobile installation



Figure 7: Mobile automated installation for the TPP defining

The heat source controller module is provided in Figure 8. The heat source controller is connected to the heat source machine control device on the heat source side and to the load equipment side.

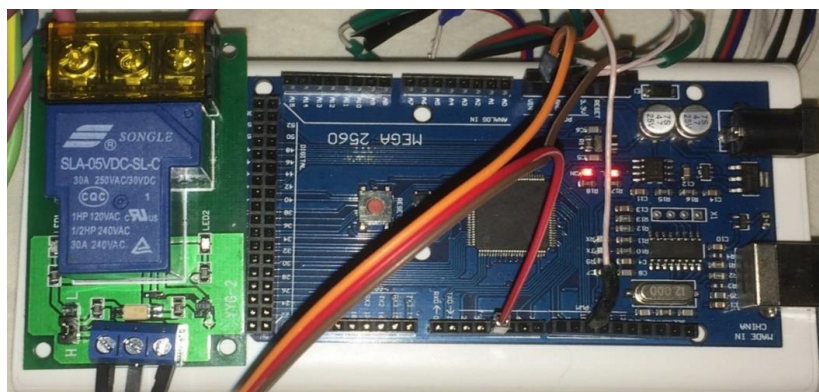


Figure 8: The heat source controller module.

The heat source controller module is designed as an Arduino Mega 2560 unit on the basis of an ATmega2560 microcontroller. The DS18D20 temperature sensors, the SLA-05VDC-SL-C relay, and the TF Cardreader module are integrated into the microcontroller via the connection wires to save the data obtained during the experimental study. The equipment is presented in Figure 9.

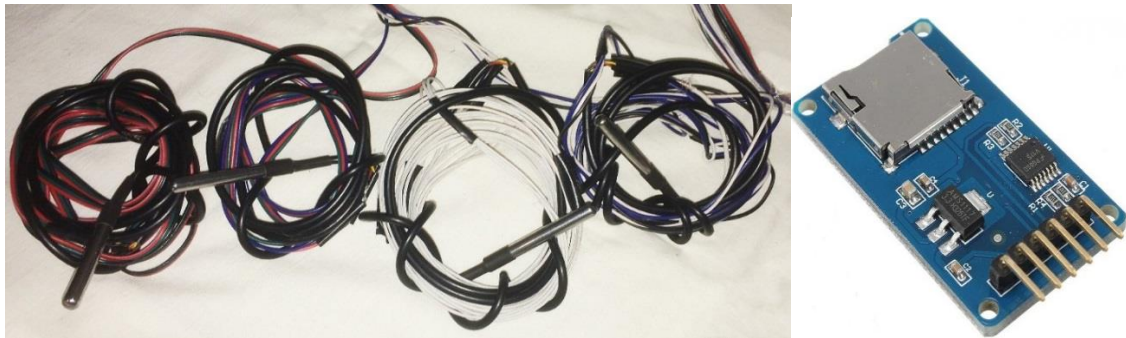


Figure 9: Temperature sensors DS18D20 and TF Cardreader.

Figure 9 shows the temperature sensors DS18D20 which are configured to work with maximum accuracy (tenths of a degree), the effective value is averaged by 10 measurements, which allows you to accurately track temperature changes. The module shown in Figure 10 was designed to estimate the ambient temperature and save the obtained values.

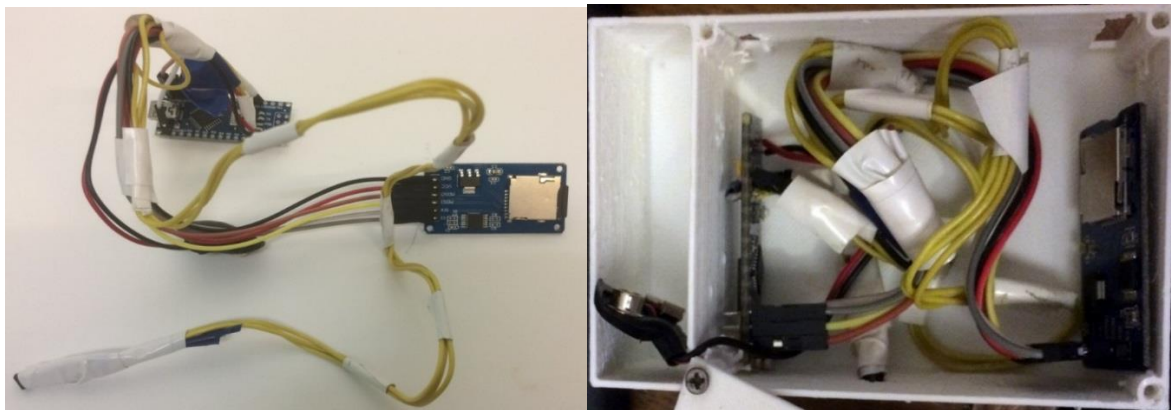


Figure 10: Module for ambient temperature measurement on the outer side of the object of study

It should be mentioned that the ambient temperature is measured with a thermometer while room temperature is based more on feeling. The ambient temperature of an environment may vary greatly from its accepted room temperature, such as when an air conditioner or heater malfunctions. Figure 11 shows the schematic circuit diagram of the ambient temperature measurement module.

The code of the ambient temperature module control program is provided in (Kabanov et al., 2018). It should be mentioned that the ambient temperature measurement module comprises an ArduinoNano 3.0 microcontroller (ATmega328), a DS1820 temperature sensor that connects to the microcontroller, and a TF Cardreader module for recording and storing the data obtained in the experiment (Panfilov & Kabanov, 2017).

The Wi-Fi module shown in Figure 12 was also used as a module for recording ambient temperature readings for objects with large overall dimensions.

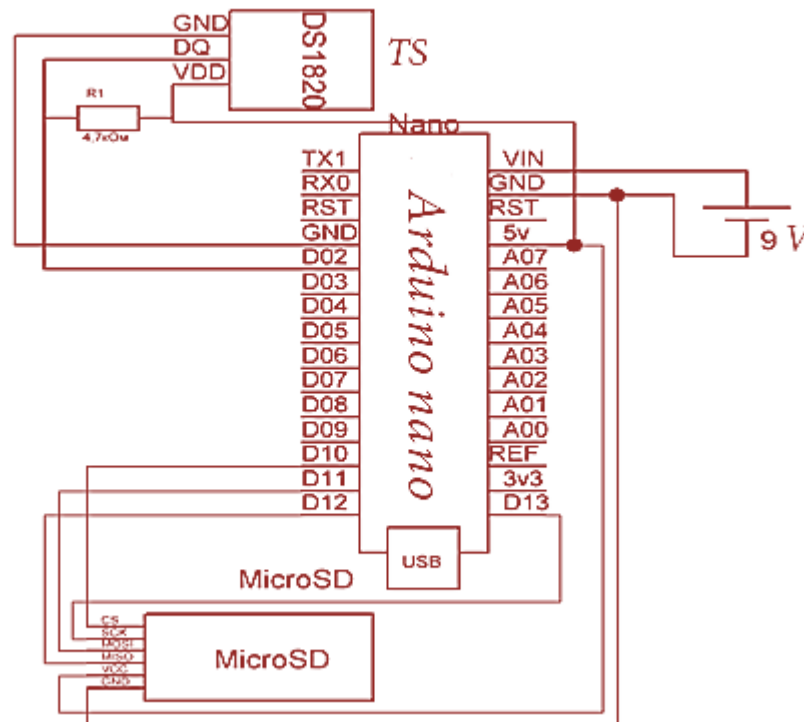


Figure 11: Schematic circuit diagram of the ambient temperature measurement module

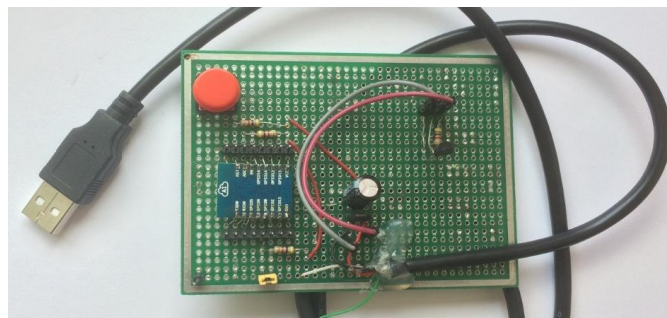


Figure 12: The WiFi module to measure the ambient temperature with input to Mega 2560

Previous technical data (TD) lists have enclosed thermal features for numerous materials that are used to the packaging of electronics. The TD for the mentioned subject is broader in the area and addresses commonly used materials. Understanding of heat capacity and thermal conductivity (THC) of things that used to create or support a test set is required to understand the consequences.

Table 1: Construction Material Thermal Properties at Room Temperature (Incropera et al. 1996; Wilson 2008).

Material	THC	Specific Heat	Density
Concrete – cast dense	0.4	1000	1200
Concrete – cast light	1.4	840	2100
Brick	0.7	840	1600
Glass (window)	0.8	880	2700
Granite	1.7-3.9	820	2600
Hardwoods (oak)	0.16	1250	720
Softwoods (pine)	0.12	1350	510
Polyvinyl chloride	0.12–0.25	1250	1400
Acoustic Tile	0.06	1340	290
Paper	0.04	1300	930
Particle board (low density)	0.08	1300	590
Particle board (high density)	0.17	1300	1000
Fiberglass	0.04	700	150

Table 1, some famous materials and their thermal features were listed. It should also be mentioned that some materials absorb water and for this reason, their features are changed. For instance, the THC of some materials such as wood may increase by 15% when wet. Some materials which used as insulators that rely on air, such as fiberglass blankets, exhibit a greater change in features when wet. It is worth noting that the range of THC's for these materials is rather modest (about two orders of magnitude).

Table 2, calculated values of THC and specific heat properties by the proposed method were provided for listed materials in Table 1.

Table 2: Calculated values construction Material Thermal Properties at Room Temperature.

Material	THC	Specific Heat
Concrete – cast dense	0.46	1125
Concrete – cast light	1.24	983
Brick	0.63	837
Glass (window)	0.91	964
Granite	2.37	796
Hardwoods (oak)	0.21	1421
Softwoods (pine)	0.14	1596
Polyvinyl chloride	0.24	1190
Acoustic Tile	0.05	1254
Paper	0.06	1470
Particle board (low density)	0.10	1364
Particle board (high density)	0.21	1404
Fiberglass	0.04	805

By comparing Tables 1 and 2, it can be seen that the proposed model has a good efficiency for calculating the thermophysical properties of an object. The developed installation is capable of determining the thermophysical properties of an object, as well as the spatial pattern of the distribution of heat flows inside the object, using non-destructive testing.

5. CONCLUSION

It is composed of a breadboard mock-up board, a DS18D20 temperature sensor coupled via connecting wires and passive electrical circuit elements (resistors and capacitors) onto the ESP8266 chip to transmit readings to the Arduino Mega 2560 microcontroller and other equipment fitted with a Wi-Fi signal receiver.

The INTERSKOL TP-5 mobile automated installation for detecting the object's FPS data on the basis of the heat source has the following specifications:

- defines the effective heat loss by nondestructive testing;
- power supply parameters of the plant $220 \pm 10\%$ V, frequency of power supply network 50 Hz;
- thermal capacity from 3 kW to 5 kW;
- designed specifically for indoor research up to 400 m³;
- continuous-time of research for up to 24 hours;
- measurement error $\pm 3\%$.

The main outcome of the study is introducing a procedure to determine the thermophysical property of the mechanical system using nondestructive methods. In this regard, a code using C++ language has been written for the mobile automated system. It works in setting the necessary values -

the time of examination, temperature maintaining period inside the examined object.

6. REFERENCES

- Ametistov, E. B. (2000). Fundamentals of heat exchange theory. Method of the non-destructive control of the thermal-physical properties of the materials. *Publishing house: Moscow Energy Institute*, 242 c.
- Barilovich, V. A., & Smirnov, Yu. A. (2014). Fundamentals of the technical thermodynamics and the theory of heat and mass transfer: Teaching guide. Moscow: INFRA-M Research and Publishing Center, 432 p.
- Bogoslovsky, V. N. (2013). Construction Thermophysics (Thermophysical Basics of Heating, Ventilation, and Air Conditioning): Textbook for Higher Education Institutions. *Publishing house: Book on Requirement*, 416 p.
- Fokin, V. M., & Chernyshov, V. N. (2004). Non-destructive control of the thermal-physical characteristics of the building materials. Moscow: Publishing house: Machine-building-1, 211 p.
- Fokin, V. M., & Kovylin, A. V. (2009). Theoretical bases for the determination of the thermal conductivity, volume heat capacity and thermal conductivity of the materials on the thermal measurements on the surface by the nondestructive control method (in Russian). *Vestnik Volgograd State University of Architecture and Civil Engineering. Edition "Construction and architecture"*, 14(33), 123-127.
- Incropera, F. P., Dewitt, D. P., Bergman, T. L., & Lavine, A. S. (1996). Introduction to Heat Transfer, John Wiley & Sons.
- Kabanov, O. V., & Panfilov, S. A. (2017). Algorithm of operation of the automated plant to determine the thermal and physical properties of objects. *Modern scientific research and innovation*, 2, 75–81.
- Kabanov, O. V., & Panfilov, S. A. (2017). Method of a Building Object Thermophysical Property Determination. *Journal of Engineering and Applied Science*, 12(11), 9056-9060.
- Kabanov, O. V., Khremkin, A. S., & Panfilov, S. A. (2017). Patent No. 2637385. Russian Federation. IPC G01N 25/72. Portable automated complex for the determination of the thermal-physical properties. Bul. No. 34.
- Kabanov, O. V., Panfilov, S. A., & Khremkin, A. S. (2016). Method for determination of the thermal properties of the construction objects. *Vestnik East-Siberian State University of Technology and Management*, 5(62), 49-57.
- Kabanov, O. V., Panfilov, S. A., Khremkin, A. S., & Bobrov, M. A. (2014). Development of the method for determination of the thermal physical properties of the object. *Journal of Science and Technology Vestnik of the Volga Region*, 5, 253–256.
- Kabanov, O.V., Yazovtseva, O. S., & Panfilov, S. A. (2018). Patent No. 2018613711. Russian Federation. IPC G01N 25/18. Program for the automated control system of the object thermal mode.
- Kudinov, A. A. (2015). Heat and mass exchange: Training guide. Moscow: INFRA-M Research and Publishing Center, 375 p.
- Malyavina, E. G. (2007). Heat Loss of the Building: A Reference Book.
- Panfilov, S. A., & Kabanov, O. V. (2016). Determination of thermal-physical properties of facilities. *Journal of Engineering and Applied Science*, 11(13), 2925-2929.
- Panfilov, S. A., & Kabanov, O. V. (2017). Method for determination of the real heat losses of the existing construction objects. *Vestnik South Ural State University. Construction and architecture" series*, 4, 52–61
- Panfilov, S. A., Kabanov, O. V., & Khryomkin, A. S. (2016). Patent No. 2016612034. Russian Federation. at. 2016612034 Russian Federation. Program for the system of the automated determination of the thermal-physical properties of the investigated object.
- Panfilov, S. A., Lomshin M.I., Sergushina, E.S., Kabanov, O.V. (2019). An Analytical Review of Methods for Determining Heat Loss of a Building Object. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*. 10(16), 10A16M: 1-12.

Thermal protection of buildings, (2012). Construction Directives and Rules 50.13330.2012 updated version instead of Thermal protection of buildings. Construction Directives and Rules (23-02-2003).

Vavilov, V. P. (2009). Infrared thermography and thermal control. Moscow: Spectrum, 544 p.

Vidin, Yu. V., Ivanov, V. V., & Kazakov, R. V. (2018). Engineering methods of calculation of heat exchange problems [Text]: monograph. Moscow: INFRA-M Research and Publishing Center; Krasnoyarsk: Siberian Federal University, 166 p.

Wilson, J. (2008). Thermal Properties of Building Materials, Electronics-Cooling, <http://www.electronics-cooling.com/2008/02/thermal-properties-of-building-materials>



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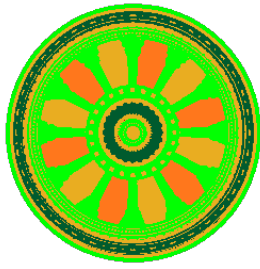
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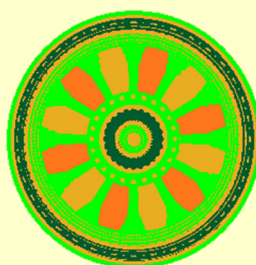
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